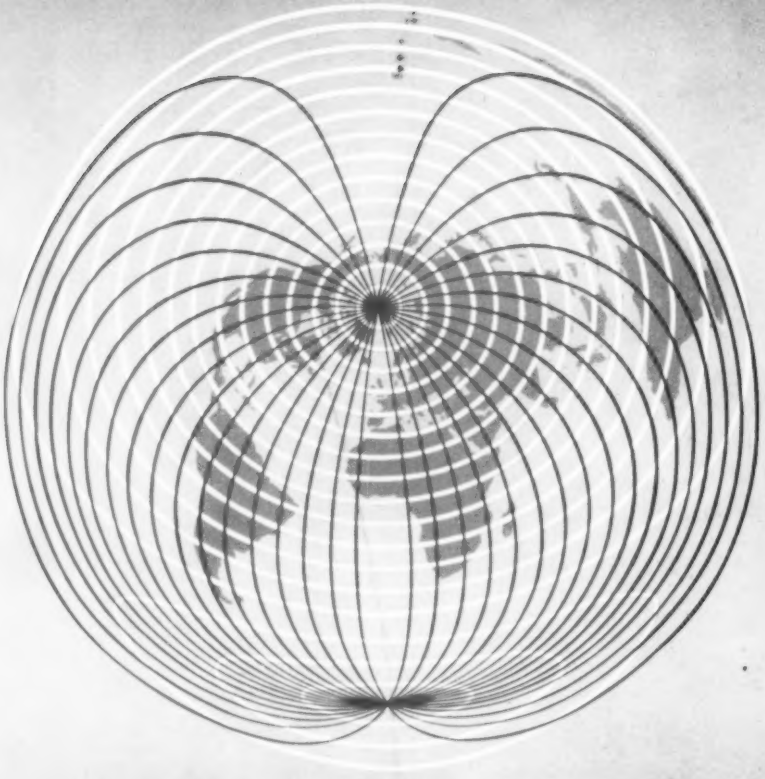
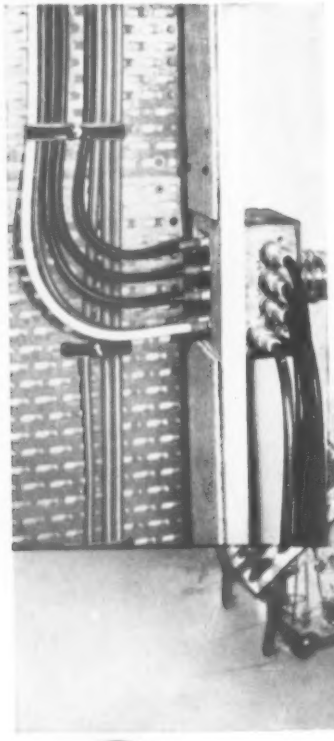
Wireless World

JUNE 1952 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

B.B.C. INSTALL BICC R.F. CABLES IN LIME GROVE T/V STUDIOS



These double screened co-axial BICC Radio Frequency Cables were recently installed by the BBC in their new T.V. Studios at Lime Grove, Shepherds Bush, London. They are used in the distribution network carrying television picture and other video wave forms to studios and control rooms throughout the building. For identification purposes BICC supplied these Radio Frequency Cables in seven colours.

This is another example of BICC service to suit individual requirements.

B.I. Callender's

RADIO FREQUENCY CABLES

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

AVO

WIDE RANGE *Signal* GENERATOR

An inexpensive yet precision instrument designed especially to meet the exacting needs of the modern service engineer and laboratory technician. With six frequency ranges covering 50 Kc/s. to 80 Mc/s., its accuracy is better than ± 1% of the scale reading.

50 Kc/s.-150 Kc/s.	1.5 Mc/s.-5.5 Mc/s.
150 Kc/s.-500 Kc/s.	5.5 Mc/s.-20 Mc/s.
500 Kc/s.-1.5 Mc/s.	20 Mc/s.-80 Mc/s.

Scale sub-divisions provide more than adequate discrimination for use in television circuits. Note the starred features below, which combine to maintain a minimum signal of less than 1μV up to 20 Mc/s. and less than 3μV between 20 Mc/s. and 80 Mc/s.

1 **★OUTPUT**
Co-axial socket for attenuated output. Force socket located totally within H.F. compartment.

2 **MAINS TRANSFORMER**
Marked tagboard for inputs of 100–130 V. and 200–260V., A.C. 50/60 c/s.

3 **★CAST ALUMINIUM H.F. COMPARTMENT and CHASSIS**
Large number of fixing holes for H.F. compartment cover ensures excellent electrical bonding and good screening.

4 **FUSE**
Easily accessible when replacement is necessary.

5 **VALVES**
Standard types run at a rating to ensure long life.

6 **TURRET COIL SWITCHING**
Standard "AVO" practice.

7 **★ATTENUATOR SYSTEM**
Employs close tolerance, high stability midget carbon resistors, low reactance rotary potentiometer modified for H.F. operation with carefully designed screening.

Other features include:

ILLUMINATED SPOT RANGE SELECTOR
Gives rapid identification of operational band with intensified lighting round precise frequency. Fine hair line gives close discrimination, particularly on high frequencies.

STOPS
Separate stops prevent turning of dia with respect to condenser.

★MAINS FILTER SYSTEM
This is screened from main electrical assembly.

BUSHING PLATES
provide additional rigidity for rotary controls.

SLOW MOTION DRIVE
substantially free from backlash.

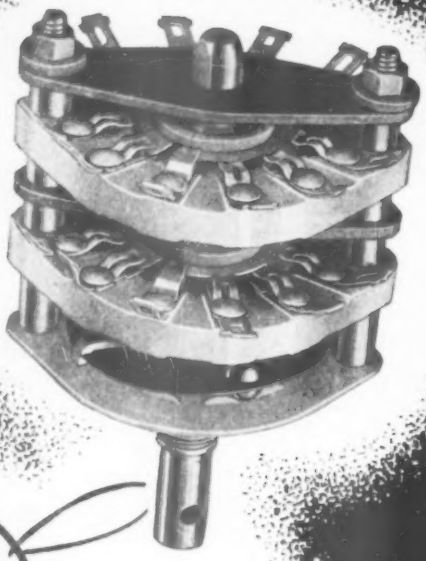
MAINS MODEL 100—130 V. and 200—260 V. A.C., 50—60 c/s. OR BATTERY MODEL ..... £30.

Sole Proprietors and Manufacturers :—

The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON • S.W.1 *Telephone: VICTORIA 3404/9*

SG.2

Ceramic Switches by



A.B. Metal Products are proud to announce that their famous H Type range of Switches is now available with "CERAMIC" insulation.

Stators and Rotors are manufactured in best quality electrical Porcelain, giving the highest degree of insulation, together with first-class Radio frequency Characteristics.

Early deliveries can be quoted, and we invite your enquiries.

Write for illustrated brochure :—

A.B. Metal Products Ltd

16, BERKELEY STREET, LONDON, W.1.

'Phone : Grosvenor 5206 7

New Standard of Efficiency in a V.H.F Power Tetrode

The Mullard power-tetrode, QY3-125, is the most efficient valve of its class in the world. Its outstanding characteristics include low driving power, low power consumption, and high power gains at V.H.F. With a maximum anode dissipation of 125 Watts, this valve will give an output of 375 Watts up to 120 Megacycles, and 225 Watts up to 200 Megacycles. The QY3-125 is particularly recommended for use as an oscillator or R.F. amplifier in compact communications and allied electronic equipments, operating in the V.H.F. range.

SPECIAL FEATURES

- ★ **Low-inductance Anode Lead — Higher Frequency Performance**
- ★ **Double Helical Filament — Low Inductance and Low Hum**
- ★ **Bottom Screen Shield — Low Anode/Filament Capacitance**
- ★ **Zirconium Coated Carbon Anode — Continuous Gettering**
- ★ **Powdered Glass Base — Low R.F. Losses**
- ★ **American Giant 5-Pin Base**

Full technical details of this and other types in the Mullard range of all-glass V.H.F. valves will be supplied on request to the address below.

PRINCIPAL CHARACTERISTICS OF QY3-125		
FILAMENT	V_f	5.0 V
	I_f	6.5 A
CAPACITANCES	C_{in}	11.2 $\mu\mu$F
	C_{out}	4.2 $\mu\mu$F
	$C_{a\text{-}g1}$	0.05 $\mu\mu$F
LIMITING VALUES	V_a max	3000 V
	p_a max	125 W
	V_{g2} max	600 V
	p_{g2} max	25 W
	I_k max	270 mA
	(full ratings) f max	120 Mc/s
	(reduced ratings) f max	200 Mc/s
BASE		B5F

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT.,
CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2.

MVT 115

PREMIER RADIO Company

(REGD.) RADIO TELEVISION

ESTAB. 40 YRS.

S. H. MORRIS & CO. (RADIO) LTD.
Please quote Dept. W.W.

Now available in this country . . .

RONETTE for

TAPE RECORDING
AMATEUR RADIO
PUBLIC ADDRESS

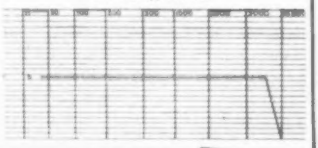
BALL TYPE CRYSTAL
HIGH FIDELITY MICROPHONE

TYPE 0-88 5

Screw fitting for any Standard type Stand.

TYPE 0-88 5 incorporates the famous RONETTE Filter Cell insert giving extreme sensitivity and high fidelity. Response is flat from 20-7500 cps. The microphone is vibration and shock-proof and is not affected by low frequency wind noises. Completely screened and absolutely damp-proof.
Screw fitting suitable for any British or American standard type floor stand, or for use as a hand microphone.

BRIEF SPECIFICATION: Output impedance, equivalent to approximately .0025 mfd. Omni-directional. Frequency response: Flat from 20-7500 cps. Recommended load resistance: 5 megohms for flat response at low frequencies.



PRICE £3 · 19 · 6

The above is especially recommended for use with the PREMIER MAGNETIC TAPE RECORDER

★ **WE ARE PROUD TO ANNOUNCE that we have obtained the SOLE AGENCY for the RONETTE BALL TYPE CRYSTAL MICROPHONE. We confidently claim that the superb performance of this Microphone will amaze you.**

THIS IS OUR ONLY ADDRESS

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TERMS OF BUSINESS:
Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/- unless otherwise stated

Telephones: AMBassador 4033
PADdington 3271/2

OPEN UNTIL 6PM ON SATURDAYS

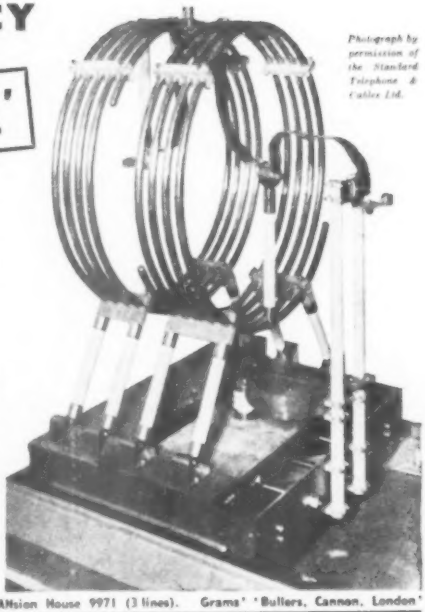
FOR HIGH-FREQUENCY INSULATION

specify **'FREQUELEX'**

The Coupling Coil shown is supported by our "FREQUELEX" Ceramic Rods, and forms part of a 200 kW. Radio Transmitter.
This is only one of many applications where Rods made to close limits are required.
We specialise in the manufacture of Ceramic Rods and Tubes of various sections in several classes of materials over wide dimensional ranges.
The principal materials are :

1. **Porcelain for general insulation.**
2. **Frequelex for High Frequency insulation.**
3. **Permalex and Templex for Capacitors :**

The degree of accuracy depends on the size of the Rod or Tube, but the standard degree of accuracy is outlined in the Inter-Service Component Manufacturers' Council—Panel R Specification embodied in our Catalogue of Radio Frequency Ceramics, copy of which will be sent on request.
Large Rods up to 44" long and 1¼" square are used as supports for Tuning Coils, etc.
We shall be pleased to have your enquiries for all sizes of Tubes and Rods. Prompt deliveries can be given for most sizes.



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Bullers
LOW LOSS CERAMICS

BULLERS LIMITED, 6 Laurence Pountney Hill, E.C.4. Phone: MANsion House 9971 (3 lines). Grams: 'Bullers, Cannon, London'

BL36

PREMIER RADIO Company

(REGD.) RADIO

S. H. MORRIS & CO. (RADIO) LTD.
Please quote Dept. W.W.

ESTAB. 40 YRS. TELEVISION

The NEW
PREMIER MAGNETIC TAPE RECORDING KIT

£29 · 8 · 0
(Carriage and Packing 15/-)

Including ALL parts, Valves, Cabinet, Loudspeaker, Reel of Tape and Rewind Spool, but excluding Microphone.

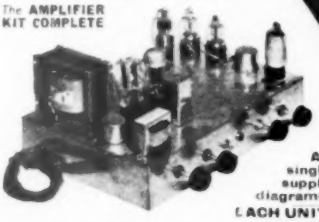
The kit incorporates the ***NEW MODEL*** **LANE TAPE TABLE** already assembled and ready for use, a **6 VALVE SPECIALLY DESIGNED AMPLIFIER KIT** including **Bias and Erase Oscillator for use with the above unit, A REEL OF TAPE** and a **WELL MADE WALNUT FINISHED TABLE CABINET** to house the complete unit. Outside dimensions when closed: Height 13¼in., Length 17in., Depth 13¼in.

INSTRUCTIONAL BOOKLET 2/6
This is credited if a complete Kit of the Tape Recorder is ordered.

SPECIAL FEATURES of the Amplifier include separate Bass and Treble lift controls, high and low gain Input Sockets, Record Playback indicator, etc. May be fed from Microphone, pick-up or directly from the Speaker terminals of your radio. Chassis size 14" × 9" × 2½".

The **PREMIER MAGNETIC TAPE RECORDING KIT** when completed compares favourably with all existing makes.

The **AMPLIFIER KIT COMPLETE**



SPECIFICATION of the ***NEW*** **LANE TAPE TABLE:—** Made to high standards and incorporating features ensuring low level of "Wow" and "Flutter" throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run in less than 1 min. in either direction. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAYBACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record play-back head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half track size allowing approx. 1 hr. playing from standard 1 200ft. Reel of Tape.

TAPE SPEED 7½in. sec.
For use on A.C. 200/250, 50 cycles mains only.

The ***NEW*** **LANE TAPE TABLE**

As is usual in all PREMIER KITS every single item down to the last nut and bolt is supplied. The chassis is punched and lay-out diagrams and theoretical circuits are included.

EACH UNIT MAY BE PURCHASED SEPARATELY

PREMIER AMPLIFIER KIT INCLUDING 8in. SPEAKER	PREMIER TABLE CABINET	*NEW* LANE TAPE TABLE
£7 · 19 · 6	£4 · 18 · 6	£16 · 10 · 0
2/6 packing and carriage.	5/- packing and carriage.	7/6 packing and carriage

This Recording Outfit has been designed for use with M.C.-1-111 SCOTCH BOY Magnetic Tape. With this high quality tape a frequency range of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½in./sec. can be readily achieved.
1,200ft. reels 35/-

WORKING MODELS CAN BE SEEN AT THE ADDRESS BELOW

MICROPHONE OFFER *For details see page opposite*

SPECIAL OFFER—The above Unit built and ready to plug in, complete with Reel of Tape and Ronette 0-88 5 Ball Type Crystal Microphone.

£36. 10. 0
(plus £1-1-0 packing carriage and insurance)

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Telephones: AMBassador 4033 PADdington 3271/2

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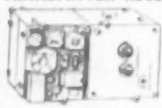
PREMIER RADIO Company

REGD. E. H. MORRIS & CO. (RADIO) LTD. EST. 40 YRS.

Please quote Dept. W.W.

RADIO

TRANSMITTER RECEIVER TYPE TR9H



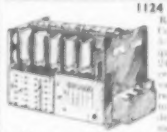
Consists of Transmitter type T1306 and Receiver R1139 in one case. This is a 9-valve Battery operated Unit covering 4.3 M.c/s. to 6.6 M.c/s. Crystal controlled, complete with valves, 50/-, plus 7/6 packing and postage.

12 v. POWER SUPPLY UNIT and L.F. AMPLIFIER

A 12 v. vibrator power pack and amplifier combined. Unit contains 12 v. Mallory Vibrator with filter components, 2 selenium metal rectifiers approximately 240 v. 20 mA. 1-ATP4 valve, various chokes, transformers and a host of other useful components. Housed in a metal case measuring 11½in. wide 6in. deep, 4in. high.

Price 29 6, plus 5/- Pkg. & Carr.

1124 RECEIVER UNIT



Range 10 to 40 m.c/s. Contains six new Valves 3-SPD, 1-4P1L, 1-1D1P (frequency changer 1-4D1, 24 ceramic trimmers, 6 ceramic valve-holders, 6 valve screening cans, 20 resistors, 3 pot-meters, mica and tubular condensers, ceramic coil formers 3-way 4-bank switch with long spindle I.F. transformers etc. Brand new in makers carton at 22 6 plus 2/6 postage and packing.

BRAND NEW R1155 RECEIVERS

In original cases, complete with 10 valves. Frequency range 18.5 M/cs.–7.5 m/cs in 6 wave bands. £11 15/-. 10/6 packing and carriage.

POWER SUPPLY UNIT for above incorporating output stage. Supplies an output of 250 volts at 80 Ma. which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6½in. speaker is built into the unit. Price £5 5/-. Plus 5/- packing and carriage.

BRAND NEW R1355 RECEIVERS

As specified for the Inexpensive Televisor, complete with 11 valves. 39 6, plus 7/6 packing and carriage.

Govt. Surplus Ex-W.D. AERIALS — BRAND NEW!

10ft.—3 sft. screw-in sections of copper-plated steel, highly flexible with non-stick screw fits, tapering fin. to ¼in. Brand new in container, 6 9. Also plug-in type 3 9. Packing and carriage 1/-. Insulated Base 2 6.

These aerials make ideal fishing rods

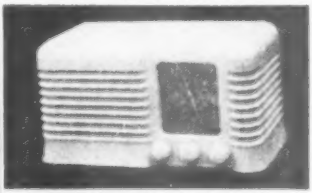
HEADPHONES

Balanced Armature Low Resistance
Type 1. 5.11 pair Type 2. 8.11 pair
High Resistance
12 6 pair
Lightweight High Resistance
14 6 pair

ADMIRALTY REFLEX-RE-ENTRANT P.A. LOUDSPEAKERS

Visually obvious. Matching transformers 1-5-1 and 6-1 ratios with volume control at max. Very sensitive and directional. Twin Units 75/-. Plus 3/- carriage and packing.

BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TO-DAY'S PRICE



We can supply all the parts to help you.

Bakelite Cabinet (Brown or Ivory)	17 6
Packing and insurance	2 6
Punched chassis, 5-valve plus rectifier T.R.F.	3 9
Engraved Glass Dials, 150-250 and 500-2,2000 m.	1 6
With station names, new wavebands	
T.R.F. Coils, 180-550, 800-2,200 metres, pair	6 6
Drum, 12in. diam.	1 6
Dressing lead	1 0
Double pointer	44
Spring	3d.
Nylon cord (yard)	6d.
Dial Front Plate	2 6

SEND 1 6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.

THE COMPLETE KIT

to construct a 5 valve plus rectifier TRF Receiver for use on 200/250 v. A.C. mains can be supplied at £6 9 6, plus 2/6 packing and carriage.

Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated and the Receiver housed in a Bakelite Cabinet size 12in. × 8in. × 8in. presents an attractive appearance. The valve line-up is 12A8—H.F. Pentode, VR116—Detector, APT4—Output, and Metal Rectifier.

Wavebband coverage is for the medium and long bands. Choice of Walnut or Ivory coloured Cabinet.

AVAILABLE ONCE AGAIN! A.C.R. 2X C.R. TUBES

5½" dia. screen. 4 Volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television. 15/- plus 3/- Pkg. Carr. & Ins.

V.C.R. 97 C.R. TUBES

We are once again able to offer this fine, as tube with the usual PREMIER guarantee of a full screen picture free from out-off. Every tube is television picture tested before despatch.

£2.5.0 Plus 5/- postage, packing and insurance

PREMIER'S MOST SENSATIONAL OFFER THE FAMOUS 'SOBELL' 4 VALVE SUPERHET TABLE RECEIVER

M. & L. WAVEBANDS

Valve Line-up 12D1, 1p5s 1A7, 3Q5GT.

Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.

Choice of 6 Colours—Walnut, Pastel Peach, Ivory, Ice Blue, Aero Green, Magenta. Carrying handle incorporated in design. For use on 200/250 AC/DC mains.

£8 · 19 · 6 Plus 5/- Pkg. Carr. Ins.

Covered fully by Manufacturer's Guarantee

ACCUMULATORS

By world-famous maker, 2 volt 10 amp. 4 11

EX-U.S.A. U.H.F. AERIAL

with untuned detector stage, consisting of V.R.91 valve, etc. Brand new, in carton 5/-.

IMPORTANT ANNOUNCEMENT: All prices quoted in our advertisements are those ruling at the time of submitting advertisement copy, and are subject to alteration without notice.

TELEVISION

EX-R.A.F. TRANSMITTER T1154 SERIES

A medium High Powered Transmitter for C.W.—M.C.W. 3 Frequency Ranges 10-5.5 m/cs. 5.5-3 m/cs. 500-200 k/cs. T.Stup Mechanism is arranged so that predetermined frequencies can be held or returned to. Complete with 4 valves—2-PT15 pentodes as parallel driven by an ML6 in a series fed Hartley oscillatory circuit. A further ML6 valve provides a 1000 cycle side tone to enable the operator to log his transmission on C.W.

Price 39 6 plus 10/- Pkg. & Carr.

2 STAGE QUALITY AMPLIFIER COMPLETE with 10in. ENERGISED LOUDSPEAKER

4 watts output. A.C. 110/230 mains.

£6.19.6

plus 5/- carriage.

MAINS NOISE ELIMINATOR KIT

Two specially designed chokes with three smoothing condensers with circuit diagram. Cuts out all mains noise. Can be assembled inside existing receiver. 6/- complete.

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C. D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and disc recording and sound projectors. Price 22 6.

CAR BATTERIES—*BRAND NEW*

6 v. 11 plate WALKER Hght. 6¼in., Lgth. 7¼in. Dpth. 6¼in. Price 65/-.

6v. 15 plate READING Hght. 7½in., Lgth. 9½in. Dpth. 7in. Price 75/-.

6 v. 19 plate DELCO-REMY. Hght. 7¾in., Lgth. 9½in. Dpth. 7in. Price 97 6.

6 v. 23 plate DELCO-REMY. Hght. 9¼in., Lgth. 13¼in., Dpth. 7½in. Price 130/-.

12 v. 9 plate WALKER Hght. 9¼in., Lgth. 13½in. Dpth. 6¼in. Price 110/-.

ALL PRICES PLUS 7/6 CARR. & PACKING

GERMANIUM CRYSTAL DIODES

Wire ends, midget size. The ideal Crystal Detector, G.E.C. or B.T.H. 4 6.

METAL RECTIFIERS FULL WAVE

6 v. 1 amp., 4/- 12 v. 1 amp. 6/-.

E.H.T. Pencil Type:

Output 850v. 1 mA., 4 7 each. 1,000v. 1 mA., 6/- each.

SPECIAL OFFER PREMIER De Luxe BABY ALARM

Owing to increased production facilities we are now able to offer this Unit at almost half the original cost.

£6.19.6

Plus 7/6 post, carr.

This is a completely wired and tested amplifier housed in a grey resin-covered cabinet. Entirely self-contained for use on A.C. or D.C. mains supply of 200/250 volts, already assembled and ready to plug in.

The unit is so constructed that in addition to functioning as a Baby Alarm, provision is made on the control panel so that the unit can be used as a gramophone amplifier and as a means of amplifying speech. Ideal for use at parties and all similar functions.

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Telephones: AMBassador 4033 PADdington 3271/2

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IMPORTANT ANNOUNCEMENT WE CANNOT ACCEPT RESPONSIBILITY FOR, NOR CAN WE GUARANTEE AN...

PREMIER RADIO Company

(REGD.) B. H. MORRIS & CO. (RADIO) LTD. (STAT. 42 YRS.)

Please quote Dept. W.W.

RADIO

4-WATT 'GRAM AMPLIFIER

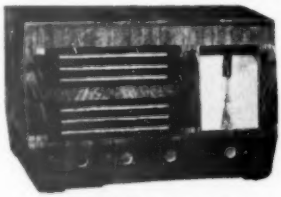
This is a converted ex-Govt. unit, incorporating a 6V6 OUTPUT STAGE giving excellent reproduction on Gram. Complete in a metal case finished in grey enamel. Outside dimensions (approx.): 9in. long, 6½in. high, 5in. deep. Price £6 10 -. Plus 5/- packing and carriage.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT

All parts to construct an eliminator to give an output of 120 volts at 20 mA, and 2 volts to charge an accumulator. Uses metal rectifier. £2.

RADIO CABINET (WALNUT FINISH)

Outside dimensions: 17½in. high, 10½in. deep, 20in. wide.



Price £2 2 6, plus 7/6 carr. pkg.

SUPER QUALITY TELEVISION MAGNIFYING LENS

To suit 10in., 9in. or 7in. Tubes. Increase picture size considerably. 25 - each.

CORRECT ASPECT WHITE RUBBER MASK

For 12in. Round or Flat faced Tube 16 11

SORBO RUBBER MASKS

Grey Felt Finish (New Aspect Ratio). 9in., 5/- ; 12in. 9/6.

THE COLLARO 3RC511 3-SPEED AUTOMATIC RECORD CHANGER

A new large purchase enables us to offer these fine Motor Units at **NEW LOW PRICES** which are approximately 25% off the current list prices. Designed for simplicity and reliability at low cost. The Pick-up can be moved to any position whilst the machine is stationary or raised without interfering with the mechanism. It is impossible to jam the mechanism and it should never go out of adjustment. The machine will play either 9-10in. or 9-12in. records not intermixed. The Motor is suitable only for A.C. supplies of 100-125 volts or 200-250 volts at a frequency of 50 cycles per second. The unit is supplied with a Dual Purpose Crystal Pick-up fitted with a **Permanent Sapphire Stylus** suitable for use with either long playing or standard recordings. All Pick-ups are fitted with a twin ball race Pick-up base, thus ensuring perfect freedom of movement. The Motor plate is finished throughout in a special hammer finish and is virtually scratch proof. The complete Unit occupies a space 15in. × 12½in. 4¾in. above the Motor Board and 2¼in. below.

PRICE £11 · 11 · 0 *Including Purchase Tax*

Plus 5/- Pkg./Carr./Ins.

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. 50 cycle MAINS.

Cat. No.

2002 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator £1 2 6

2003 Charges 12 volt accumulator at 1 amp. £1 7 6

CARBON HAND MICROPHONE

Super quality, with switch in handle. Type 3A, 4/11.

PORTABLE ELECTRIC AUTO-CHANGE RECORD PLAYER AND AMPLIFIER COMBINED

This unit consists of a 5-valve amplifier (1 Mullard EL32 and 1 Mullard EF37A) and a Plessey auto record-changer which will play 5 records 10 and 12in. mixed. Housed in a handsome Rexine covered cabinet, nickel plated fittings with strong leather carrying handle. Impregnate 16in. wide, 12in. deep, 9in. high. For A.C. mains only.

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THE FAMOUS "CHANCERY" HIGH FIDELITY MICROCELL PICK-UP—TYPE GPX *for Standard and Long Playing*

The Chancery Light Weight GPX Pick-up embodies certain unique features achieving standard of performance not possible with normal magnetic or crystal pick-ups. The secret of the high standard of performance is in the use of the special microcell crystal cartridge assembly which has an unusually wide frequency response. The sapphire stylus is precision ground and semi-permanent. With one cartridge either L.P. or Standard. **Price £2 13 -**

Additional L.P. or Standard Cartridges can be supplied from stock at £1.11.6 each.

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Induction motor, 100-250 volts, 50 cycles A.C. only. The GARRARD Induction Motor is totally enclosed. Entirely free from radio frequency disturbance, magnetic hum and electrostatic. Variable speed. With 12in. Turntable. Price £5 17 6. Plus packing and carriage 5/-.

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"Golden Wing" Playing Desk, consists of the famous Collaro RC500 Autochanger Unit, single speed 78 r.p.m. Mag. Head, mounted on attractive metal plinth.

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Ditto (Unmounted, with Crystal Head)	£11 16 9
Collaro 3 speed "Golden Wing" Playing Desk, consists of the famous Collaro 3RC511 3 speed Autochanger Unit mounted on attractive metal plinth, with dual purpose Head suitable for long playing and standard recordings	£12 2 11
Ditto (Unmounted, with two separate plug-in Heads, one long playing one standard)	£18 14 1
Collaro single speed rim drive Unit with plug-in Mag. Head. 78 r.p.m.	£18 14 1
RcR Model GU4 3 speed Gram unit, incorporates the latest type of Crystal turnover Head for long playing and standard recordings	£6 10 6
Garrard Gramophone Motor. Variable speed induction Motor. Complete with 12in. turntable (this Unit does not include Pick-up)	£9 19 11
Connoisseur 2 speed Gram. Unit LESS Pick-up	£5 19 6
Pick-up with 2 Heads for above	£22 18 8
Conrad Rim Drive Gramophone Unit LESS Pick-up Arm 78 r.p.m.	£10 0 8
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Decca 3 speed Rim Drive Gram. Unit LESS Pick-up	£4 7 5
Decca Single Speed Rim Drive LESS Pick-up, 78 r.p.m.	£6 8 6
Ditto, 33 r.p.m.	£3 14 4
Decca Pick-up with 2 Heads, one long playing, and one standard	£3 14 4
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Please add 5/- extra for packing and carriage charges on Gramophone Units.	£23 13 0

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A 50 v. 3 phase A.C. motor, 1/40th h.h.p. by famous maker. Supplied complete with resistor, condenser and circuit diagram to convert the motor to ¼ h.p. for use on 240 v. single phase A.C. mains. Brand new 25 - plus 2/6 carriage and packing.

TELEVISION

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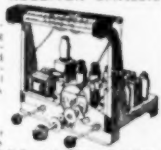
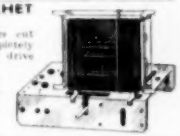


built to exacting specifications and incorporating features ensuring superlative tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 46 Valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection, A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 Kc/s using Mazda VP41. **FOUR WAVEBANDS 14 M.-24 M., 24 M.-56 M., 190 M.-550 M., 800 M.-2,000 M.** DIRECT AND VERNIER TUNING. 4-way position on switch. Provision for external Loudspeaker. **£13 10 -** plus 21/- Pkg. & Carr.

7-VALVE SUPERHET CHASSIS



All control mountings cut out, fitted with completely assembled full vision drive scale, long medium and short wavebands and band spread. Heavy flywheel tuning. **19 6.** plus 2/6 pkg and carr.

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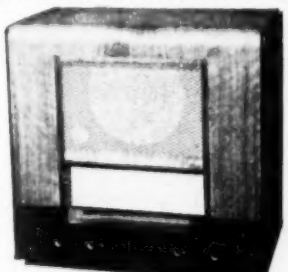
Outside dimensions: 18½in. high, 9in. deep, 12in. wide.



A beautifully made cabinet. £2 10 - plus 7/6 carr. pkg.

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Drilled and cut out, or all necessary control mountings and Mains Transformer, fitted with 5 Amphenol Octal Valveholders, Aerial, Earth and Gramophone Sockets. 500 pf Tuning Gang Condenser, full vision drive Tuning Assembly consisting of unbreakable perspex 3-coloured scale for long, medium and short wavebands. Calibrated in metres, kilocycles and station names, price **39 6.**

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FOR TELEVISION

THE improvement in television components, with their smaller size and greater efficiency, is largely due to Ferroxcube, the new Mullard magnetic core material.
The uses of Mullard Ferroxcube in the production of TV components fall into these three main groups:

LINE OUTPUT TRANSFORMER CORES

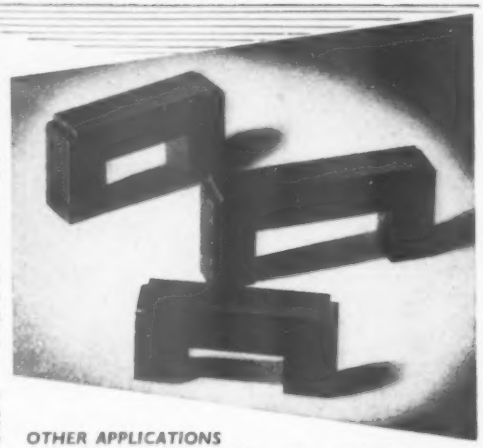
Since the advent of wide-angle television tubes, with the accompanying demand for increased E.H.T. supplies, the need for line output transformers of the highest possible efficiency has been greater than ever. Mullard Ferroxcube, with its low iron losses, completely fulfils this need — also facilitating the assembly of small, compact transformer units by means of solid, non-laminated U-shape cores.

DEFLECTION COIL YOKES

Mullard Ferroxcube cores in ring form are ideal for producing the magnetic circuit around deflection coils. Used in this way, Mullard Ferroxcube makes possible the construction of efficient deflector coils with a high Q factor. In order to simplify assembly problems, these ring cores are supplied either in the form of a complete circle, as two semi-circles, or as castellated yokes.

LINEARITY AND PICTURE WIDTH CONTROLS

Mullard Ferroxcube can very conveniently be extruded into rods and tubes. In this form it is ideal for use in linearity and picture width controls, providing a smooth control in a compact assembly.



OTHER APPLICATIONS

In addition to its uses in television receivers, Mullard Ferroxcube is also being widely employed in line communications, radar, and other specialised electronic equipments. The purposes for which it is already being most successfully applied in such equipments include filter networks, wide band transformers, magnetic amplifiers, and pulse transformers.

PLEASE WRITE FOR FULL DETAILS

Mullard **FERROXCUBE**

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Trix Autogram	£44	0	0
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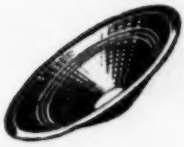

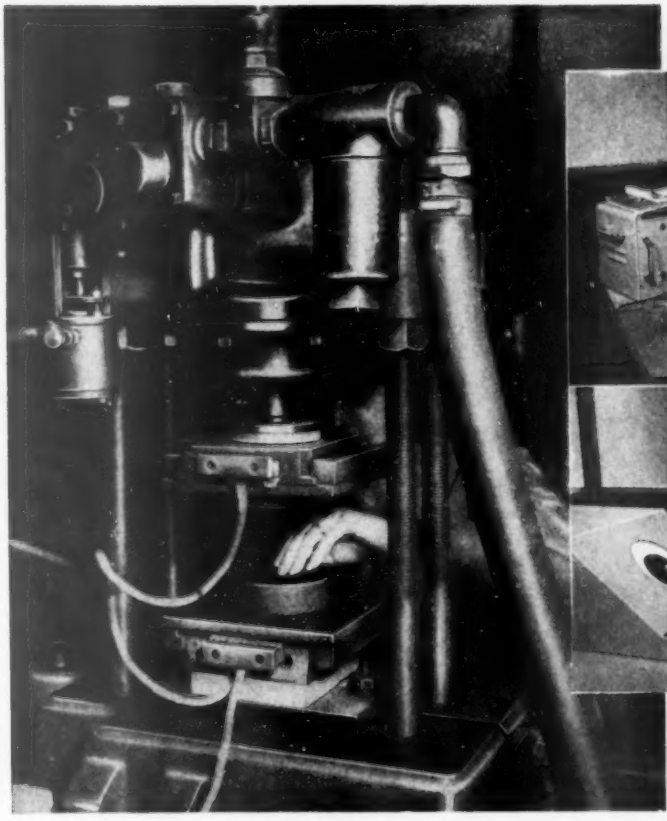

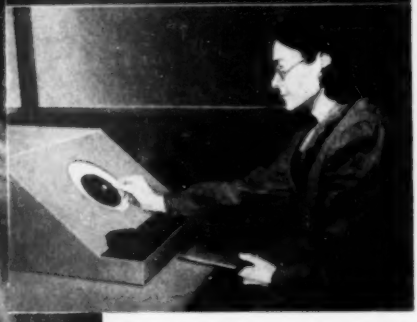

The fundamental resonance of the cone is determined by clamping the diaphragm at its periphery and driving it by another loudspeaker. This loudspeaker is fed from a variable frequency oscillator and air-coupled to the diaphragm under test. At the fundamental resonance, a noticeable increase in amplitude of the driver diaphragm is observed (*Below*) A final visual check for consistency.

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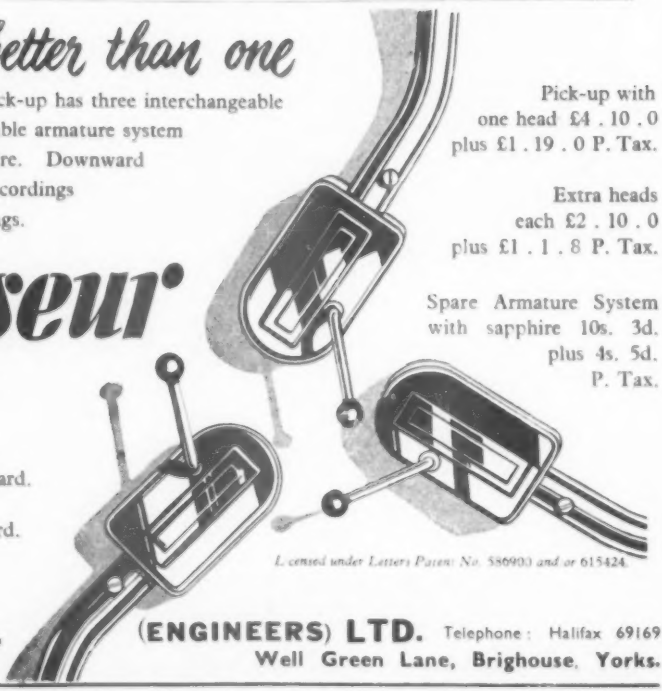
Extra heads each £2 . 10 . 0 plus £1 . 1 . 8 P. Tax.

Spare Armature System with sapphire 10s. 3d. plus 4s. 5d. P. Tax.



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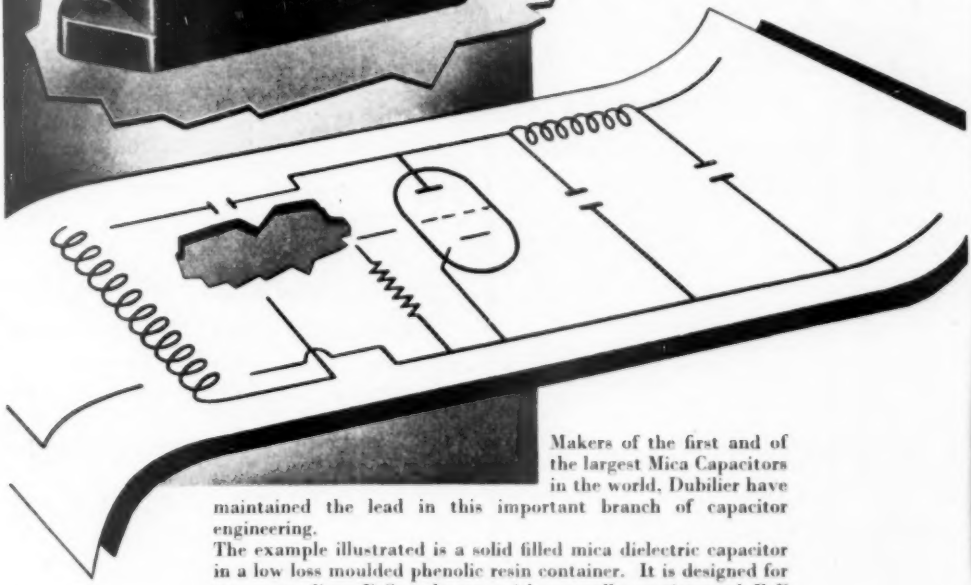

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The example illustrated is a solid filled mica dielectric capacitor in a low loss moulded phenolic resin container. It is designed for use on medium D.C. voltages, with a small superimposed R-F current, or as the tank circuit capacitor in low power medium and long wave transmitting equipment.

Full details of capacitance values and ratings are available on request.

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GENERAL PURPOSE LOUDSPEAKER & POWER AMPLIFIER UNIT

True versatility

WITH HIGH-FIDELITY

Here is a professional quality tape recorder *plus* . . . an equipment which provides a range of facilities that is truly unique. The complete equipment is in two carrying cases, one housing the recorder and the other a loudspeaker and power amplifier unit. The recorder unit employs three separate motors, one each for capstan head, magazine reel and take-up reel. The response is relatively flat to 9,000 c/s and not more than minus 6 db at 10,000 c/s. Tape speed 7½in. per sec. These two units, which together weigh under 100 lbs. and may be used independently, provide the following facilities :—

Tape Recorder Unit only

- Recording on Tape.
- Replay from Tape to line.
- Input from low impedance microphone or 600-ohm balanced line.
- Output for monitor headphone and 600-ohm unbalanced line.

Tape Recorder and Loudspeaker Amplifier Unit

Additional facilities :

- Replay from Tape at 10 w.
- Built-in monitor loudspeaker.
- Output for Studio loudspeaker (10 w.).

Both of above Units together with Disk Recording Machine.

- Copying from Tape to Disk.
- Replay from Disk at 10 w.
- Recording on Disk direct from microphone or line.

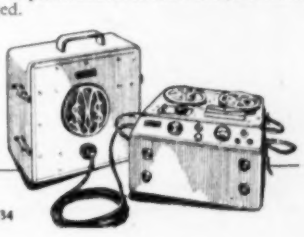
If two disk recorders are used the above facilities become continuous.

The machine includes three tape heads allowing a comparison to be made between incoming quality and recording quality whilst recording.

Fullest technical details on request

EARLY DELIVERY OF THE ORIGINAL M.S.S. TAPE RECORDER PMR/1

From the moment of its introduction in April, '51, the PMR/1 was accorded widespread acclamation. This fact was reflected in a demand that was truly overwhelming, and deliveries inevitably suffered. Thanks to improved manufacturing facilities we are now fulfilling all outstanding orders, and for the future can assure early delivery. The high standard of performance of the PMR/1 remains unchanged.



M.S.S. RECORDING CO. LTD., POYLE CLOSE, COLNBROOK, BUCKS Tel. Colnbrook 234

Variable Coils...
-and wizard performance

NEW OSMOR "Q" RANGE COILS charm away all doubts, difficulties and complications—thanks to their super-selectivity and sensitivity.

Consider these five star features :

★ **Only 1in. high.**
★ **Variable iron dust cores.**
★ **Low-loss Polystyrene formers.**
★ **Packed in damp-proof containers.**
★ **Fitted tags for easy connection.**

And they're backed by the OSMOR quality guarantee ! Supplied with leaflet giving data, circuits, etc. 4/- each.

COILPACKS. A full range is available for Super-het and T.R.F. Mains or Battery. Size only 1¼in. high x 3¼in. wide x 2¼in. Ideal for the reliable construction of new sets, also for conversion of the 21 RECEIVER, TR 1196, TYPE 18, WARTIME UTILITY and others.
Aligned and tested, with full circuits, etc. Fully descriptive leaflets available.
WARNING ! Avoid inferior imitations. Genuine OSMOR Coilpacks are sold only under the name OSMOR.

MATCHED COMPONENTS. Various types of OSMOR Dials, Chassis, I.F.S. Speakers, Transformers, etc., etc., to match our coils and coilpacks are all listed.

Send 5d. (stamps) for ***FREE CIRCUITS*** *and full lists of coils, coilpacks and radio components.*

OSMOR RADIO PRODUCTS LTD. **(Dept. W.31), BRIDGE VIEW WORKS, BOROUGH HILL, CROYDON, SURREY.** *Telephone :* **Croydon 5148 9**

FOR RADIOSMOR ELIABILITY

Speedy and Accurate
FOOT-OPERATED
WIRE STRIPPER

Ideal for production work on most types of insulated and small flexible cables up to ¼" outside diameter. Hyde Stripping Machines are cutting the costs and speeding the production of many world famous manufacturers. Send samples of wires or cables used, for full report.

For cables up to ¼" outside diameter having solid or inflexible conductors, ask for details of the Hyde BENCH TYPE Cable Stripper, which has straight or parallel action.

Sole Distributors, Stockists and Demonstrators :

BUCK & HICKMAN LTD.

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ALPERTON: 264 Water Road, Abbey Estate
BIRMINGHAM: 29/32 Whittall Street, 4
MANCHESTER: Adair Street, 1. (P.O. Box 148)
GLASGOW: 49 Robertson Street, C.2

THE ACRU ELECTRIC TOOL MFG. CO. LTD.

We are pleased to advise all customers that we have opened a new factory, and our new address is

Chapel Street, Stockport Road, Levenshulme, Manchester 19
(Telephone No. Rusholme 4613)

Our plant and machinery have been considerably increased, and we will in future be able to supply with much better delivery all products from the following departments :-

GLASS BLOWING DEPT. — Neon Indicator Lamps, Testers, Mercury and Vacuum Switches.
ELECTRICAL DEPT. — Soldering Irons and Elements, Heating Elements, Hand Driers, Relays, and Thermostats with precious metals.
ENGINEERING DEPT. — Surface Plates, Spring Winders, Callipers, etc.

Your enquiries will be dealt with in the promptest manner

BRITISH BSR THROUGHOUT SPECIALISTS

RADIO & TELEVISION
ELECTRICAL APPLIANCES
ELECTRIC TOOLS
KITS

RADIO CENTRE

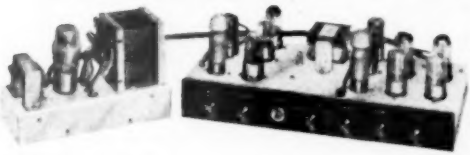
TEST EQUIPMENT
HI-FI REPRODUCTION
TAPE RECORDERS
AMPLIFIERS

Sole Distributors for all 'BURGOYNE' PRODUCTS

ANOTHER "BURGOYNE" QUALITY PRODUCT

Presenting the

"BURGOYNE" MAGNETIC RECORDING AMPLIFIER KIT



The "Burgoyne" Magnetic Recording Playback Amplifier is capable of giving a quality of reproduction limited only by the frequency response of the tapes and heads employed in any system. The amplifier actually consists of **two completely independent sections**. The first section is a recording amplifier, which has provision for microphone, gramophone, or radio input, and mixing between these inputs is possible.

The recording amplifier is provided with a separate monitor channel for use with headphones, thus giving the recordist intimate contact with the material being recorded. A magic eye indicator gives a positive indication of the recording level, thus preventing overmodulation of the tape and consequent distortion. The oscillator employs the latest "Burgoyne" oscillator coil in a circuit which produces a clean erase and leaves the tape with a virtual silent background. In order that the system may be used with any tape a variable HF bias control is provided.

20 gns. cash
H.P. TERMS
Deposit £7
12 m'thly p'm'ts of 26/8
Instruction Manual 5/-
Cost credited if kit purchased.

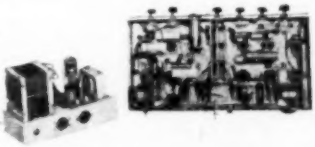
The mic. input is specifically matched for the Acos Mic 22-2 which is a good all round high-quality microphone.

The playback amplifier employs a total of 7 valves in a circuit of advanced design specifically intended for high-quality reproduction. In addition to completely independent treble and bass controls, negative feed back is used in order to increase the damping factor and at the same time to give a perfectly linear response in the circuits after the equalisers.

The pre-amplifier is a EF37A high gain low noise, low hum pentode and by the choice of suitable associated components, a signal to noise ratio of 70 db is attained.

In order to obviate any hum due to stray magnetic field round the mains transformer and at the same time to avoid the formation of earth loop currents, the power unit is constructed on a separate chassis which is linked to the main amplifier chassis by means of a multi way cable.

The "Burgoyne" amplifier described above employs a total of 14 valves in an arrangement expressly designed for the connoisseur in tape recording.



RECOMMENDED ASSOCIATED EQUIPMENT

As mentioned above, we specifically recommend the **ACOS MIC 22-2** as illustrated, which incorporates the ACOS filter cell which gives extreme sensitivity and high fidelity. The response is substantially flat from 40 to 6,000 cps. Price **£6.6.- cash** or **deposit 36/-** and 12 monthly payments of **10/10**.

SCOTCH BOY TAPE is the finest tape available and we have ample stocks at **35/-**, a 1,200ft. reel, spare reels **4/6**.

For monitoring, we recommend the **S. G. BROWN TYPE F LIGHT-WEIGHT HEADPHONES**, which are of extremely robust construction. Cobalt steel magnets and stalloy diaphragms are used. 4000 ohm D.C. resistance. 14,000 ohms at 1,000 cps impedance. **35/- per pair.**

We have a very wide range of high fidelity loudspeakers and can particularly recommend the Bakers Single Cone 12in. chassis at **6.15.-** or **deposit £2.15.-** and 12 monthly payments of **10/-**.

The **"BURGOYNE" TAPE TABLE** is eminently suitable for use with the "Burgoyne" Amplifier. As previously advertised this is still available at **£16.10.- or £6.10.- deposit** and 12 monthly payments of **20/-**. The "Burgoyne" Tape Table while not only giving first-class value for money, is a sound precision production.

Finally, we have pleasure in announcing that a CABINET is now available to house your home constructed recorder. This is made of fully polished walnut with special strut hinges and two clip locking for lid, and the cut out is intended for the "Burgoyne" Tape Table. The cabinet will take any amplifier of reasonable size. Price £4.10.- or 30/- deposit and 12 monthly payments of 8/4.

For all you want to know about Magnetic Recording, read "Magnetic Recording" by S. J. Begun, price 25/- per copy.

FOR THE CONNOISSEUR . . .

A complete reproducing equipment is offered comprising

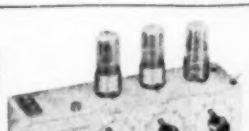
(a) The Hartley Turner tone control Pre-Amplifier . . . . . **£7.10s.**

(b) The Hartley Turner 20 watt Push Pull Amplifier . . . . . **£33.0s.**

(c) The Hartley Turner 215 Loudspeaker **£14.10s.**

(d) *The BSR GU4/DEH 3 speed motor unit fitted with interchangeable Decca 78 RPM and LP heads (converting this well-known model into a transcription quality unit) **£13.19s.**

TOTAL CASH PRICE
£68.19s.
A special easy terms offer is made to enable you to acquire the above on a deposit of £23 and 24 monthly payments of 45/-.



* An alternative to the GU4/DEH is available—the Connoisseur Dual Speed Motor Unit with lightweight pickup and 2 heads and matching transformer at **£33.14.4.**

TOTAL CASH PRICE **£88.14.4.** or **£30** deposit and 24 monthly payments of **56/6.**

All items are available separately for cash or on easy H.P. terms.

CONSTRUCTORS' OFFER

For those contemplating the construction of a tape recorder with only limited funds at their disposal, we will for a limited period of one month only, offer a basic kit comprising: 2 Tannoy Magnetic Recording Heads (one erase, two record playback, etc.); for **£6.5.0** cash and 2 Collaro motors at **£5.10.0** per pair, or the complete kit described above for

£9.19.6

E & O MAIL ORDER SUPPLY CO., *The RADIO CENTRE*
Dept. WW, 33, TOTTENHAM COURT ROAD, LONDON, W.1.
MUSeum 6667

M·O·S

TRADE and EXPORT INQUIRIES INVITED

Send S.A.E. for lists of equipment available on H.P. Terms

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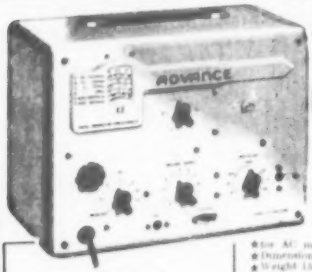
TERMS OF BUSINESS

H.P.: Send deposit with order, which will be dispatched upon signing H.P. Agreement

CASH: Cash with order or C.O.D. if goods suitable for post



ADVANCE SIGNAL GENERATOR

TYPE E2

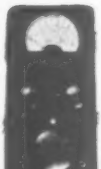
★Covering all frequencies between 100 kc. 100 mcs. in fundamentals.
★Accurate attenuation system.
★Directly calibrated illuminated dial.
★Internal modulation 30% at 400 c/s.
★for AC mains.
★Dimensions, 12in. × 9¼in. × 7in.
★Weight 14 lb.

Price **£28** or **£8** deposit and 12 monthly payments of 36/8

AVAILABLE FROM STOCK

All other Advance test gear available.

All makes of Test Gear available from stock.



AMPLION ALL-PURPOSE TEST METER

★ HIGHEST QUALITY MOVING COIL METER MOVEMENT.
★ SELF-CONTAINED INTERNAL BATTERY.
★ 10 RANGES.

Who would have thought that all these features—and more—could be made available in a high-grade all-purpose multi-range Test instrument for so small a cost! The outstanding sensitivity of this precision moving coil instrument makes it ideal for all who require a universal test meter for professional or amateur use.

£5 CASH or 20/- deposit and 12 monthly payments of 10/-. High-grade Leather Case if required 15/- extra.

SENSITIVITY. 1,500 ohm per volt on all D.C. and A.C. ranges.

RANGES. 10 v. 100 v. and 500 volts D.C. and A.C.
* 50 mA. and 500 mA. D.C.
* Resistance up to 500,000 ohms (3,000 ohm centre with self-contained battery).
* 5,000 volts range with a separate H.T. test prod 9/6 extra.

*Supplied with test prods.

TAYLOR-WINDSOR ELECTRICAL MEASURING EQUIPMENT

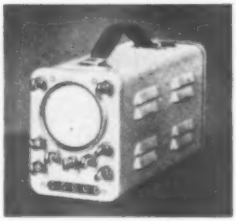
A NEW range of Test Gear by TAYLOR. This reliable range has been considerably extended and we can offer stock deliveries on all models with easy Hire Purchase terms.

MODEL	CASH PRICE	H.P. DEPOSIT	12 MONTHLY PAYMENTS
90B Circuit Analyser	£15 15 0	£4 15 0	22/-
45A Signal Generator	£22 10 0	£7 0 0	30/-
45C Signal Generator	£17 15 0	£5 15 0	23/6
44A Monitoss Pocket Meter	£2 10 0		
70A Universal Meter, 1,000 opv	£12 10 0	£4 10 0	17/-
71A Universal Meter, 1,000 opv	£12 10 0	£4 10 0	17/-
73A Universal Meter, 1,000 opv	£16 0 0	£6 0 0	20/-
74A Universal Meter, 20,000 opv	£15 0 0	£5 0 0	20/-
77A Universal Meter, 20,000 opv	£15 0 0	£5 0 0	20/-
78A P Universal Meter, 20,000 opv	£19 10 0	£6 10 0	25/-
66A Universal Meter, 20,000 opv	£21 10 0	£7 0 0	27/6
67A Universal Meter, 20,000 opv	£15 15 0	£4 15 0	22/-
120A Universal Meter, 1,000 opv	£9 0 0	£3 10 0	12/-
170A Electronic Test Meter	£24 0 0	£8 0 0	30/-
140A Pattern Generator	£14 0 0	£4 15 0	18/9
160A TV Wobulator	£36 15 0	£12 0 0	46/-
150B Valve Tester	£24 0 0	£8 0 0	30/-
88A Oscilloscope	£33 10 0	£12 10 0	40/-
130B C.R. Bridge	£11 0 0	£2 10 0	17/6

COSSOR PORTABLE OSCILLOGRAPH

Model 1039

CASH **£28** or DEPOSIT £9.6.8 and 12 monthly payments of 35/-



Height 5¼in., Width 4¼in., Length 11¼in.

The smallest in the Cossor Oscillograph range, the Model 1039 can truly be said to fulfil the requirements of a really portable instrument.
Although miniaturised and weighing only 9¼ lb. the Oscillograph is fitted with a tube of 2½in. diameter.
Model 1039 Portable Oscillograph and the Cossor "Tele-check" Model 1329 form an invaluable combination for use by all Television Service Engineers.

Tele-check available at £27. Deposit £8.6.8.
12 monthly payments of 35/-.

PIFCO All-in-One RADIOMETER 29/6 Post free

For AC and DC Circuit Component and Valve tests.

acos Combined HAND-STAND CRYSTAL MICROPHONE

Type MIC 30

A good quality general purpose Xtal microphone having a substantially flat characteristic with a high sensitivity.

£4. 4s.

Frequency response, substantially flat from 30/5,000 cps.
Output level, −55 db. ref. 1 volt/dyne/cm.²
Load resistance, 2 megohms included.
Cable length, 4ft.
On-Off switch incorporated with provision to close an extra circuit.
Finish, black or cream depending on the availability of raw materials.

The "BURGOYNE" Magnetic Recording Head

FOR SUPERIOR PERFORMANCE AT LOWER COST

Record Playback and Erase Heads giving first-class frequency response.

★HIGH IMPEDANCE ★POSITIVE FIXING METHOD ★HALF TRACK WIDTH ★TOTALLY ENCLOSED WITH TAPE GUIDE ★WIDE FREQUENCY RANGE.

Impedance 1,000 ohms at 1,000 c/s. Frequency range at 7½in. sec. up to 9,000 c/s. Approx. signal output on playback −68 db.

Illustration shows actual size of head

DISTRIBUTED EXCLUSIVELY by M.O.S.

39/6 each, post free.
Record Playback or Erase Head
Set of 2: Deposit 23/- 12 mthy. payments of 8/-
Set of 3: Deposit 38/6 12 mthy. payments of 10/-

A new range of crystal microphones particularly suitable for tape recorders.

RONETTE microphones

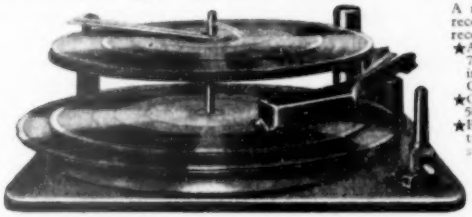
Type B110. In ivory plastic with metal screened cartridge 42/-
Type HM7. With built-in filtercell cartridge 55/-
Type S742. With two built-in light-weight sound cells. £8.15/-

LEADING DISTRIBUTORS for HARTLEY-TURNER equipment for the connoisseur
Demonstrations at the Radio Centre
DELIVERIES FROM STOCK

M·O·S

DECCA XMS PICK-UP HEADS
For Standard and L.P. recordings Types A, B, C or D
59/2 each

Presenting the **B S R "MONARCH"** *Auto-changer*



A masterpiece in design and technical excellence—a three speed automatic record changer designed to play 12in., 10in., and the increasingly popular 7in. records intermixed in any order.

★Automatically selects and plays 7in., 10in. and 12in. records, intermixed at 33⅓, 45 or 78 r.p.m. Capacity 10 records.
★Operates on 100/125–200/250 volts, 50 cycles, A.C.
★Pick-up switch automatically returned to rest position and motor switched off after last record.
★New reversible dual stylus crystal pick-up has extended frequency range to 10,000 c.p.s. Self compensated for the L.P. lower frequencies with the Turnover frequency at the correct point.
★Beautiful styling and finish that will harmonise with any cabinet design.

ORDER NOW for QUICK DELIVERY. £17. 17s., or £6 deposit and 12 monthly payments of 23/1.

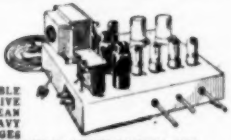
ALL B.S.R. GRAMOPHONE MOTORS

are first class, but we particularly recommend the Dual Speed Motor Unit Type M.U.10.

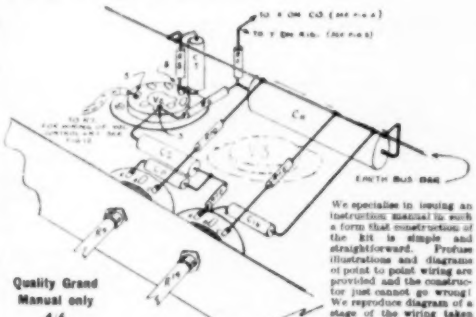
CASH 78/7

★De Luxe 4-pole motor of advanced design assures low rumble and vibration factor.
★No stray field radiation noticeable with any type of pickup.
★Uniform turntable speed under widely varying record loads.
★Self-lubricating bearings quiet running, long life to oiling.
★Speed change 78 to 33⅓ r.p.m. in a few seconds by merely reversing main drive pulley.
★Absolute minimum instantaneous speed variation (wow).
★10in. dia. heavy pressed steel turntable fitting on precision ground taper steel spindle.
★Ideal for use with any type of magnetic or crystal pickup

THE M·O·S QUALITY GRAND AMPLIFIER KIT



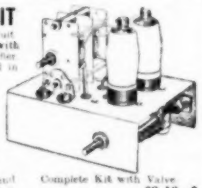
★WIDE RANGE : CONTINUOUSLY VARIABLE TREBLE AND BASS CONTROLS WHICH GIVE BOTH BOOST AND CUT ABOUT A MEAN REFERENCE LEVEL AT 1,000 C/S. ★HEAVY NEG. FEEDBACK USED OVER THE STAGES AFTER THE EQUALISER CIRCUITS, ENSURING THAT ACTION OF THE TONE CONTROL IS UNIMPAIRED BY FOLLOWING AMPLIFIER STAGES.
★NO HARMONIC DISTORTION ★7 VALVES.
★TWO INPUTS ★FOR USE ON A.C. MAINS.



We specialise in issuing an instruction manual in such a form that construction of the kit is simple and straightforward. Profuse illustrations and diagrams of point to point wiring are provided and the constructor just cannot go wrong! We reproduce diagram of a stage of the wiring taken from the manual.

Quality Grand Manual only 4/6

M.O.S. RFI RADIO FEEDER UNIT



This tuning unit uses a straight TRF circuit tuning the Medium Wave Band only. If provided with its own power unit, it can be used with any amplifier. The unit is exceptionally sensitive: can be used in areas of only moderate signal strength.

By use of a TRF circuit the bandpass is such that the output fed into an amplifier is of very high fidelity, and full advantage can be taken of the transmitted quality.

The unit is provided with only two controls—Tuning and Sensitivity—and consequently is very simple to operate. No tuning scale is provided as it is thought that the great majority of constructors will prefer to fit the unit into a cabinet and so be able to choose an assembly to suit the housing. Adequate spindle length is provided in all cases.

In line with others in the Easy-to-Build series, kit is complete in every detail, and instruction manual fully detailed and illustrated.

Complete Kit with Valve £2 12 6
Instruction Manual only 2 0
Ready assembled and Wired £3 12 6

TYPE A KIT 6V6 6V6 OUTPUT £9.19.6 cash, or £3 deposit and 12 monthly payments of 15/-. Fully assembled and wired ready to use, £12.10/- cash, or £4 deposit and 12 monthly payments of 17.6.

TYPE B KIT 6L6 6L6 OUTPUT £11/5/- cash, or £3/10/- Deposit and 12 monthly payments of 16/8. Fully assembled and wired ready to use, £13 15/-, cash, or £4.10/- deposit and 12 monthly payments of 18/9.

Introducing a

NEW 2-SPEED TAPE TABLE THE "ROYAL"

★2 Speeds: 7½in. and 15in. per sec. ★Entirely new drive principle giving complete freedom from "wow" and flutter. ★Fitted with Spool brakes. ★Self lubricating bearings. ★Fully captive, positive locking Spool holders. ★Simple switch control. ★Simple straight tape loading. ★High efficiency erase heads. ★Top plate dimensions 11½in. × 8½in. ★Depth 6½in. overall.

Specially recommended for the connoisseur interested in high fidelity recording of passages of orchestral music etc. at 15" per sec.

£16.16s. CASH or £6.4s. deposit and 12 monthly payments of 21/-

The acos GP29 DUAL STYLUS (Turnover) CRYSTAL CARTRIDGE £2.3.4 each

A new design of head for balanced reproduction of L.P. and Standard records.

acos GP20 and GP19 HEADS

still available from stock at £2.3.4 each

or complete with pick-up arm £3.11.5

VITAVOX K12/10 loudspeaker

A 12" high quality reproducer with voice coil of 15 ohms working on an effective flux density of 140,000 maxwells. 10 Watts.

£8.10s. CASH or £3 deposit and 12 monthly payments of 12/6

We can offer delivery of Goodmans AXIOM 150 Mk. II 12" High Fidelity Loudspeaker.

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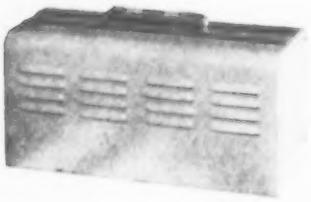
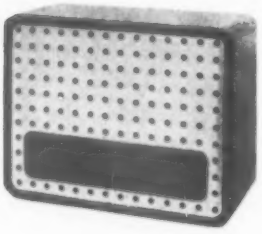
E & G MAIL ORDER SUPPLY CO., *The RADIO CENTRE*
MUSeum 6667 Dept. WW, 33, TOTTENHAM COURT ROAD, LONDON, W.1.





INSTRUMENT CASES FROM STOCK

90 per cent of our standard range of cases, including enclosed racks, is available from stock for delivery within 48 hours. Imhof standard enclosed rack units in 4ft. and 6ft. sizes 19in. deep and taking 19in. panels, and standard instrument cases in twenty-two different types and sizes are designed to meet the main needs of electronic instrument housing. They are available in any quantity from one upwards and give you the advantages of low price based on quantity production with no design worries or tool charges and NO PRODUCTION DELAYS. Please write for our 1952 catalogue and latest price list of full standard range.

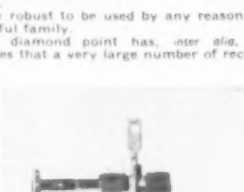
IMHOF'S

ALFRED IMHOF LIMITED, 112-116 NEW OXFORD STREET, LONDON, W.C.1. MUSEUM 7878

BRIERLEY DIAMOND MICROARMATURE PICK-UP

This new pick-up has many noteworthy characteristics, some of which are listed below :—

1. The mass of the moving parts is less, we believe, than in any other pick-up of any type—other than our own Ribbon, which is, of course, unique.
2. The output voltage—about 1·25th v.—is high enough to cause no trouble.
3. It is sufficiently robust to be used by any reasonably intelligent and careful family.
4. The use of a diamond point has, *inter alia*, the enormous advantages that a very large number of records may be played with negligible point wear. This results in a sustained "new" performance together with the elimination of that mental irritation at the gradual and perceptible "falling off" unavoidable with less wear-resistant points.
5. Organised production on a reasonable scale should give us a satisfactory "spares" and repair service and has enabled us to produce this pick-up at a price which many may at first have believed to be either a mistake or a printer's error.



A B C

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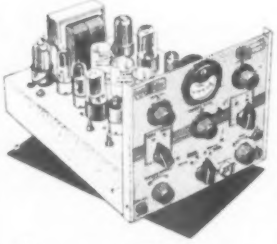

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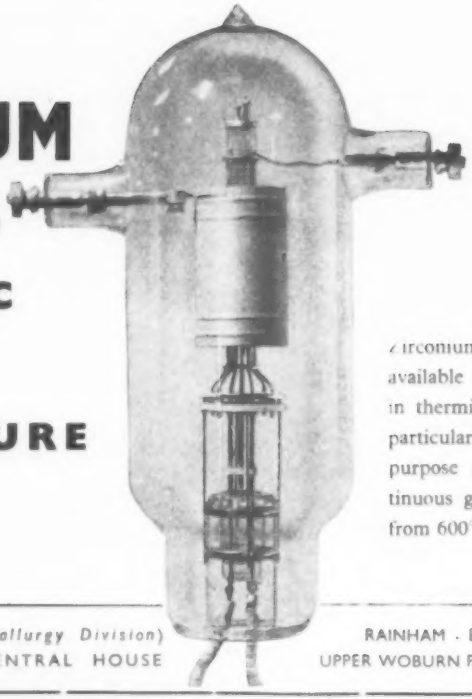

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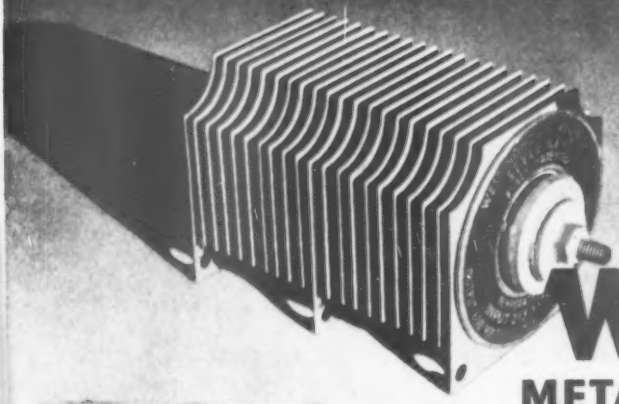

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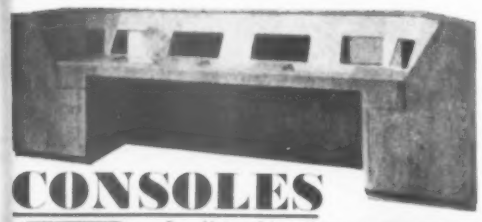

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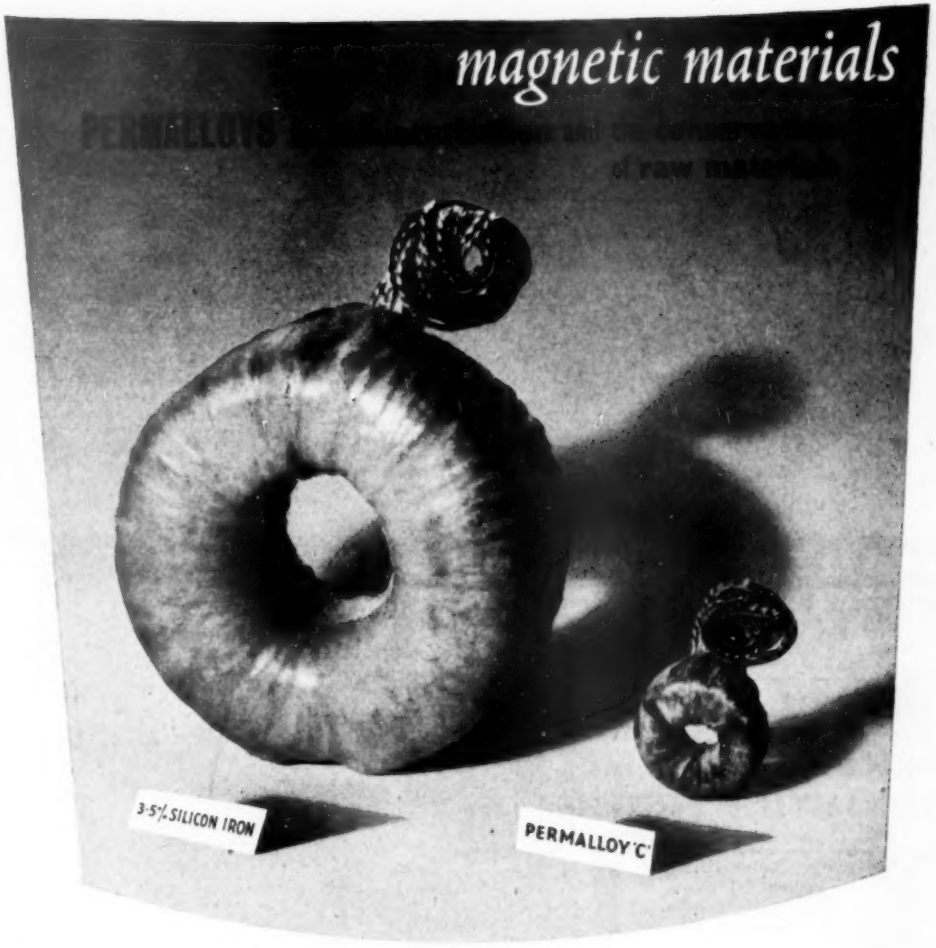

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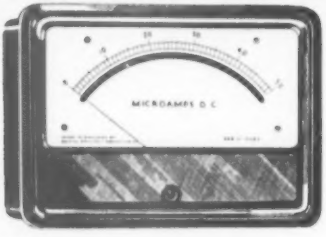

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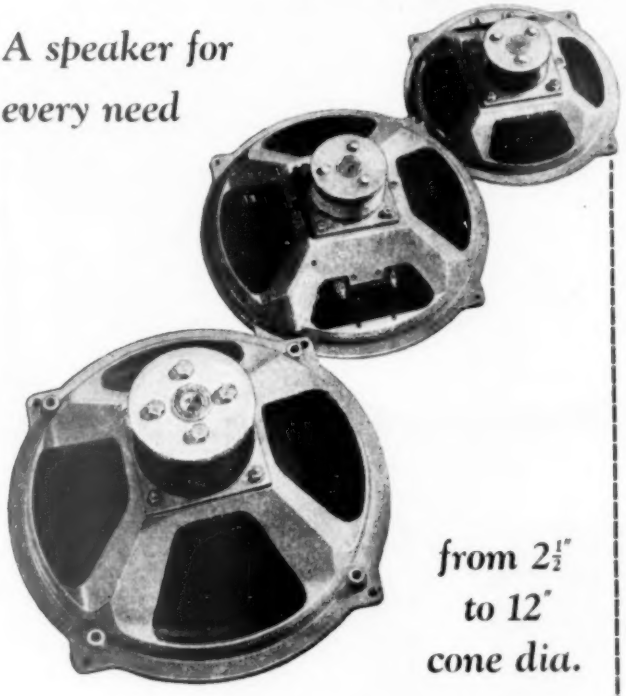

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"I am very glad to say that this speaker is giving me great satisfaction. Its frequency response, transient response and power handling capacity are truly remarkable, particularly for such a moderately priced speaker. It surpasses most other speakers I have heard, even considerably more costly ones."

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"It will doubtless be of interest to you to learn that this particular W/B 10" loudspeaker was purchased during 1928 and continues to give excellent service."

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"Thanks once again for a really fine speaker (in fact the finest speaker) in my humble opinion."

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"You may be sure that I would do my utmost to insist that your 10" Unit be used exclusively. I doubt if there is a better one of its type in the World, or even as good, and we have tried a few. This is not idle flattery, but a fact which can be demonstrated at any time."

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"I must congratulate you on producing the finest speaker unit I have had the privilege to own. Your claims regarding the performance of the 10" Concentric Duplex speaker are not in any way exaggerated. I find it ideally suited for domestic use."

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Stentorian
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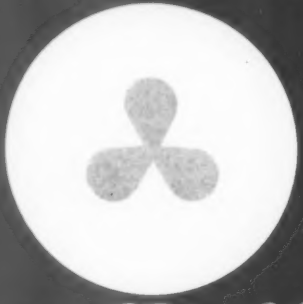

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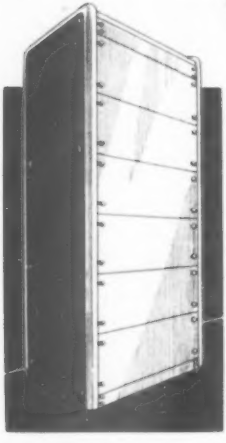

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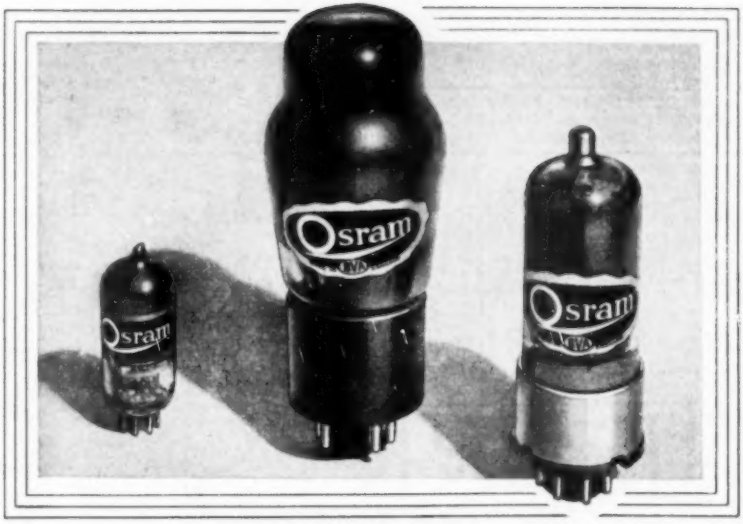

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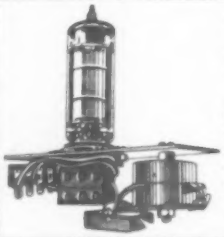

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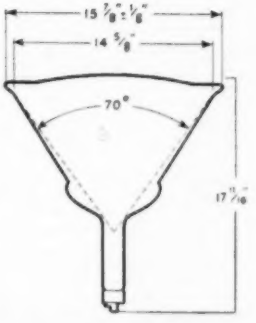

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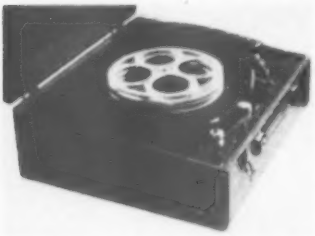

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★ 1950 We gave you tape recording utilising a gramophone motor
★ 1952 We give you now for the FIRST TIME in MAGNETIC RECORDING

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By clever circuitry we have produced for you a 2-valve translator which supersedes costly amplifiers and saves you needless expense. This unique translator will magnetically record from any microphone or pick-up. This unique translator will playback from any make of recorder. It will (without electrical connection to telephones) record 2-way conversations. It will playback into business intercom. systems. It will playback into cinema or wireless relay systems.

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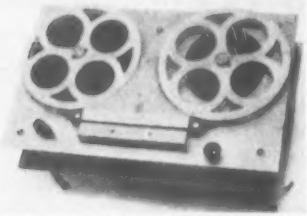

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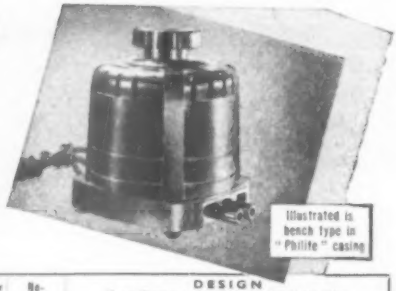

Illustrated is bench type in "Philite" casing

★ The Transformers given in the tables all have an input voltage of 220V 40-100 cycles. Models can however also be supplied for 110V or 130V input.

a = *overall diameter*
b = *depth behind panel*
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Output ★	Secondary Voltage	Secondary Current	No-Load Losses	DESIGN						
				Panel Mounting				Bench Mounting		
				Type No.	Dimensions mm.			Type No.	Dimensions mm.	
V.A.	V	A	W		a	b	c		d	e
260	0-260	1	6.8	84514	137	130	30	84515	137	165
520	0-260	2	9	84516	137	150	30	84517	137	185
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2080	0-260	8	25	84520	187	200	30	84521	215	272

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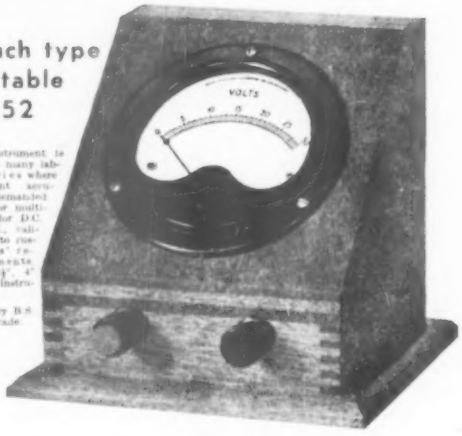

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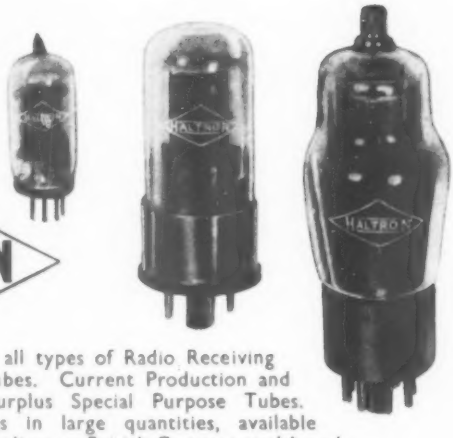

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J. Moir, FMTV (review) Oct. 1951. U.S. publication.

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The above passages dealing with transients are taken from reviews of Q.U.A.D. amplifier and Corner Ribbon demonstrations which have appeared in various technical publications.

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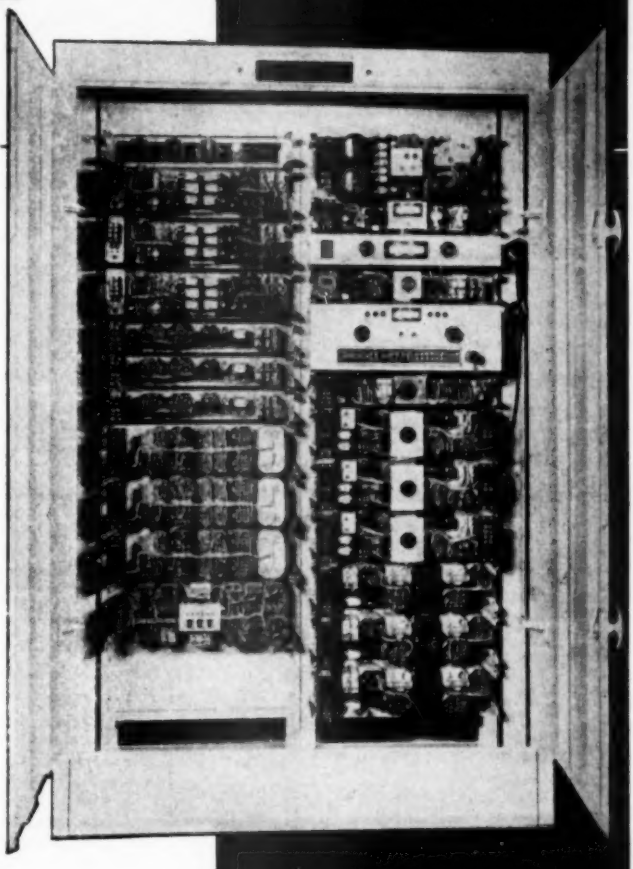

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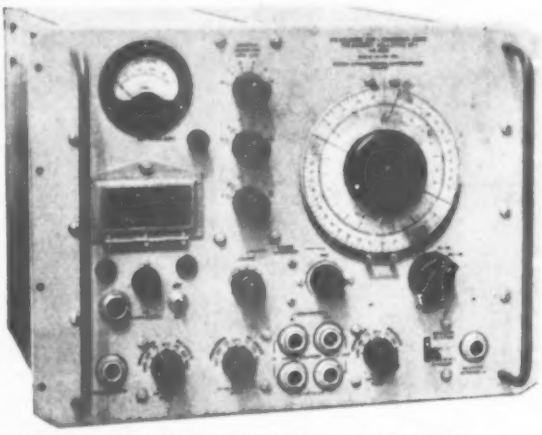

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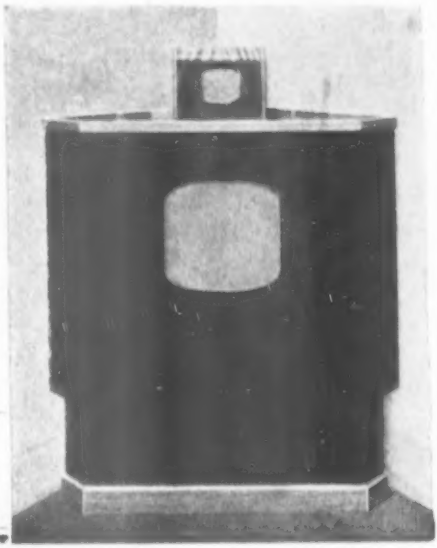

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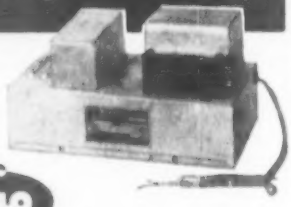

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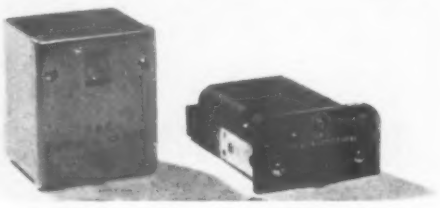

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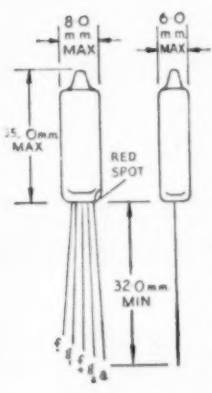
XFY33



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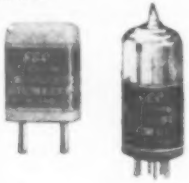

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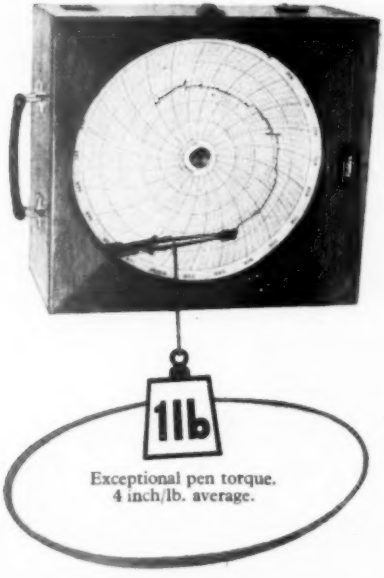

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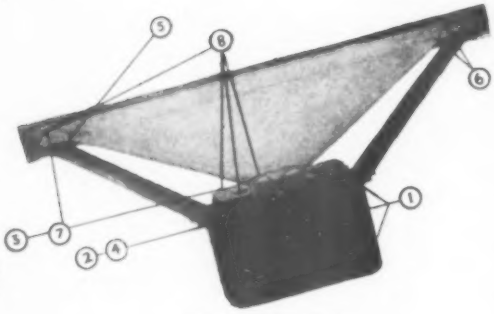

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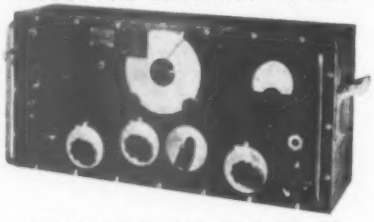

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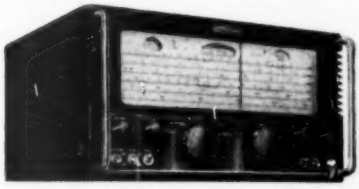

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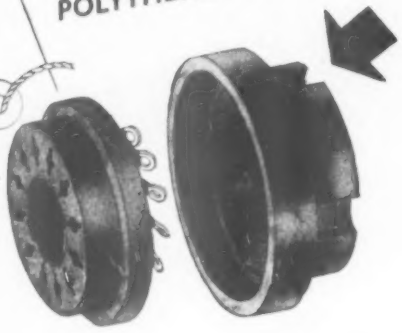

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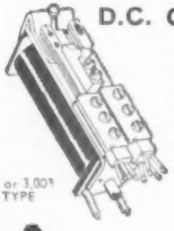

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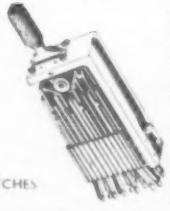

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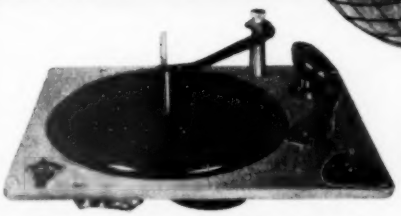

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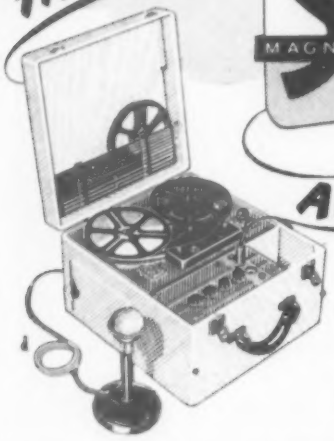

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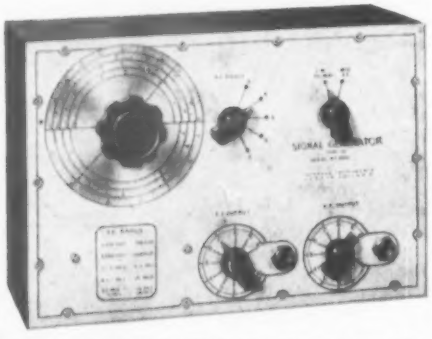

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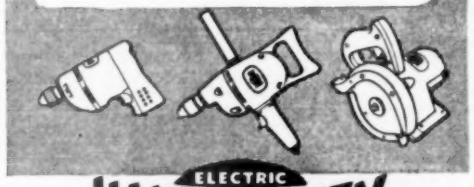

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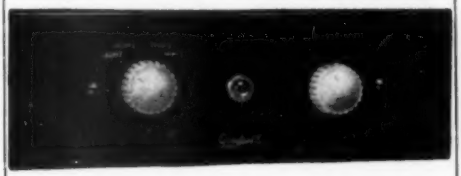

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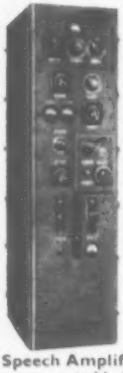

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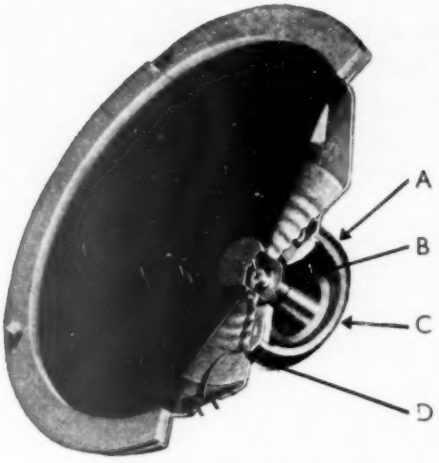

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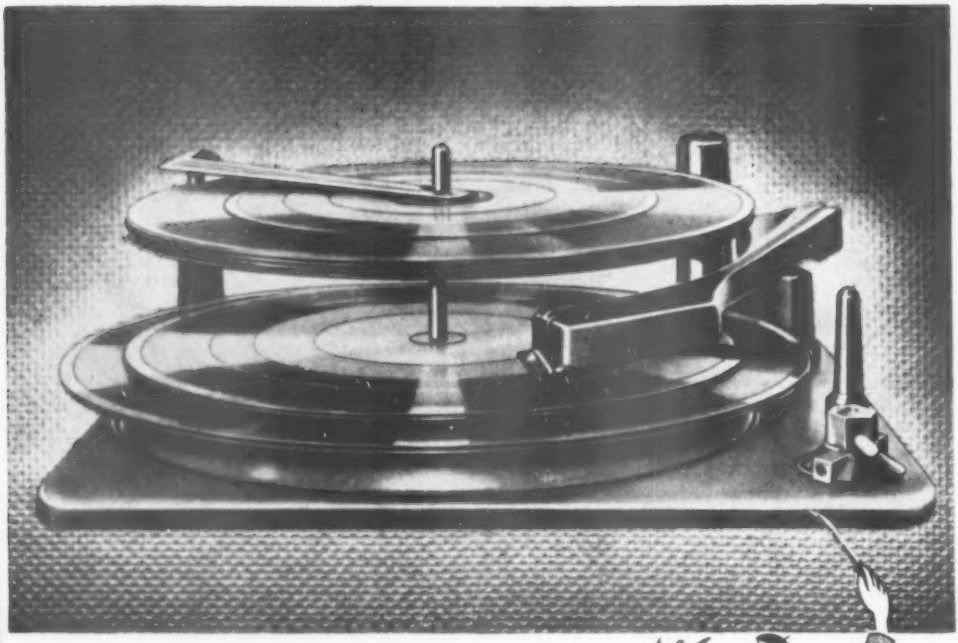

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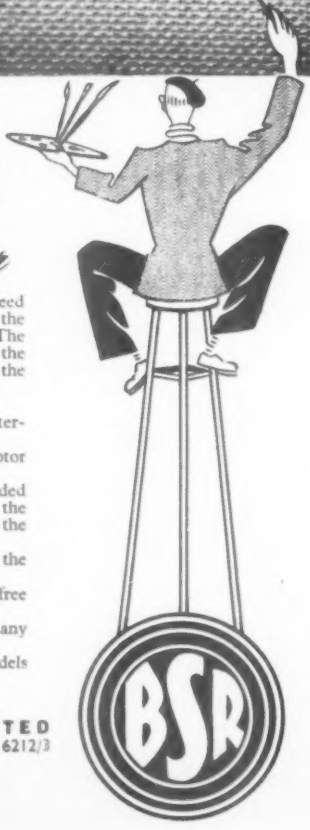

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

42nd YEAR OF PUBLICATION

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JUNE 1932

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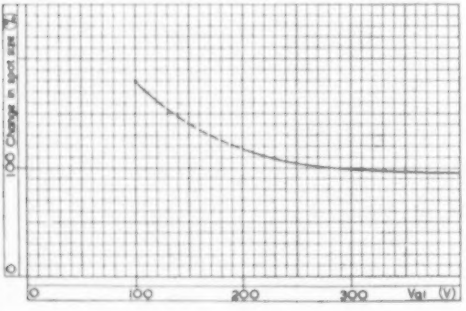
Published technical data on Mullard direct-viewing television picture tubes specifies maximum and minimum limits for the first anode potential. For example, the maxima and minima are 410 V. and 200 V. for the MW41-1 16-inch round tube and for the MW36-22 14-inch-diagonal rectangular tube.

These limits are imposed in the interest of tube performance and life, taking into consideration the following points:

From the graph reproduced below it will be seen that for a given second anode potential and beam current the spot size decreases as the first anode potential is raised. Other things being equal, therefore, an increase in first anode potential improves resolution at the centre of the picture. (At the edges of the picture, however, the improvement may not be so great.) Beyond a certain value of first anode potential, however, further increase does not substantially reduce spot size.



An upper limit to the first anode potential is, however, set by the risk of overloading the cathode. In practice, electronic emission from the cathode is not uniform throughout its area, the portion of the cathode area usefully employed being determined by the shape of the electric field in the cathode-grid region.

FIRST ANODE VOLTAGE LIMITS

If the first anode potential is increased and the operating conditions are readjusted to give the same beam current, a smaller part of the cathode surface is utilised, and the emission per unit area over that part of the cathode is increased. If the first anode potential is raised beyond a certain value the loading on that part of the cathode surface will be so great that its useful life will be reduced.

At the maximum limiting value quoted, the spot size approaches its minimum value, and any increase of first anode potential merely causes overloading of the cathode and may reduce its life without conferring any substantial advantage as regards spot size.

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MW41-1

Metal-coned tube with 16-inch diameter screen.

HEATER Indirectly heated.

This tube is suitable for series or parallel operation.

V_h	6.3	V
I_h	0.3	A

TYPICAL OPERATING CONDITIONS

V_{a2}	12	KV
V_{a1}	300	V
V_g for cut-off	−39 to −86	V
Focusing ampere-turns (approx.)	900	

LIMITING VALUES (Design centre ratings)

V_{a2} max.	14	KV
V_{a2} min.	7	KV
V_{a1} max.	410	V
V_{a1} min.	200	V
$-V_g$ max.	150	V
$+V_{g(pk)}$ max.	2	V
V_{h-k} max. (heater positive)	125	V
V_{h-k} max. (heater negative)	200	V
* $V_{h-k\ (pk)}$ max. (heater negative)	410	V
R_{g-k} max.	0.5	M Ω
R_{h-k} max.	20	K Ω

* During a warming-up period not exceeding 45 secs.

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MVM 199

Wireless World

JUNE 1952 VOL. LVIII. No. 6

Television on Parade

THE Institution of Electrical Engineers is to be congratulated on the success of the recent Convention on "The British Contribution to Television." The object was to present the more recent developments against a background of the existing state of the art, and a good deal of time will be needed for digestion of the vast amount of information presented—much of it highly specialized. When all this is issued in permanent printed form, we shall have a most valuable source of information, not only on all aspects of broadcast transmission, distribution and reception, but on subsidiary applications of television techniques. Elsewhere in this issue we describe a few of the detail receiver developments that are of wide interest, and also attempt to present a general picture of the scope of the large number of papers that were presented.

Many who attended the Convention clearly did not expect to find that British television has already acquired an antiquity value. Foreign visitors—and some others—did not know that the Baird 30-line system was in use for some five years in the '30s, and a demonstration, crude as it seemed to modern eyes, was greeted with surprisingly warm and spontaneous applause. Indeed, speculation was even heard as to what might be done nowadays by applying modern electronic practice to such low-definition systems that call for no wider bandwidth than that of a good telephony channel.

But history played a relatively small part at the Convention, which, particularly in the discussions, was distinctly forward-looking. The "perfect" television picture is economically and technically no more practicable than the perfect newspaper illustration, but many of us left the Convention with the feeling that the British 405-line system represents the best compromise for the foreseeable future. But there was no complacency, and it was urged that the new science of Information Theory be invoked to help us to make use of channels of reasonable bandwidth and also to turn such aids as stereoscopy and colour to best account.

We agree with the various suggestions that a parting of the ways is due between broadcast television and other applications of the art. In non-broadcast applications the present high price of cameras is a serious obstacle. Many branches of science and industry cannot afford them, but, paradoxically, some others may well demand stereoscopy and colour before these refinements become economically practicable for broadcasting.

Restrictive Practices

THE I.E.E. Convention, in discussing non-broadcasting television, dealt with technical problems: we sometimes have misgivings that developments here may be restricted largely by administrative or political difficulties. The withholding of licences for cinemas is a case in point.

We take some encouragement in noting that the Postmaster-General has taken his courage in both hands in allowing special television transmissions to schools. The decision must have raised a host of administrative problems to which justice could be done only by a sea-lawyer. The schools transmissions, though admittedly very like broadcasting, can hardly fall into that category, either technically or according to the official definition of the International Radio Regulations. They are beamed to specified schools and are transmitted on a frequency allotted, we believe, to the B.B.C. for relay work—not for broadcasting. The complementary sound is distributed to the schools by wire—the antithesis of broadcasting.

If the schools transmissions are not, administratively speaking, broadcasting, into what category do they fall? But we must not pursue enquiries in this direction any farther, or we may find the B.B.C. really needs a licence for a fixed point-to-point communication service or something similar from which it is debarred by the terms of its Charter. As compared with the present experimental schools service, the licensing of cinema television, or of most other applications that can be envisaged, seems to be relatively simple administratively, and we are encouraged to think that official over-cautiousness will no longer be responsible for bringing promising developments to a halt.

Television Developments

A Selection from the I.E.E. Convention of Points Applicable to Receivers

IN a convention on television it is not to be expected that a great part of the material would be descriptive of new and startling developments. The material is likely to be much more of an historical nature and descriptive of present-day practice. As always, a convention tends to be a record of the present state of the art and, therefore, much of the material presented is already well known to those versed in the subject even when it has not been previously recorded in accessible form.

In all, 83 papers were presented at the recent I.E.E. Convention. The mere list of their titles and authors would occupy two pages of *Wireless World* and any attempt to summarize their contents is obviously impracticable. All that can be done, therefore, is to pick out some items of the widest interest and, very naturally, these fall mainly on the receiving side, simply because in the nature of things there are more people interested in receiving apparatus than in transmitting.

One development of very general interest was described in the paper by G. B. Townsend, "On Overcoming the Non-Interlacing of Television Receivers which are Accurately Synchronized." This paper refers to the common case in which perfect interlacing is secured during the fly-back but poor, or no, interlacing during the scan. The condition occurs not through timing errors so much as through amplitude errors. Successive cycles are slightly different in amplitude. The effect has been previously described[1] but a remedy for it is now proposed. The arrangement is shown in Fig. 1; V_1 is the normal discharge valve and R and C are the charging resistor and capacitor respectively. The additions to normal practice comprise the diode V_2 and the potential-divider R_1 R_2 with the large capacitance C_2.

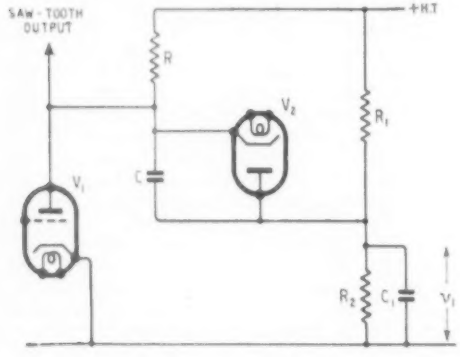


Fig. 1. The diode V_2 is added to a saw-tooth generator to improve interlacing.

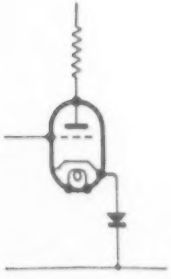


Fig. 2. Metal rectifier used as cathode-bias resistor.

During the scan V_1 and V_2 are both non-conductive and C charges through R in the usual way. The effective charging voltage is the h.t. supply less v_1 and the potential of the output terminal rises from a minimum substantially equal to v_1. On fly-back V_1 conducts to discharge C but V_2 remains non-conductive until the voltage across C has dropped to about 1 V, when it conducts and effectively joins the anode of V_1 to the voltage v_1 from the voltage divider. The diode ensures the termination of the fly-back at the same voltage level in every cycle and hence the start of the next scan from the same level.

Selenium Bias "Resistor"

A new use for metal rectifiers—as bias resistors—was described in the paper "The Applications of the Metal Rectifier in Television Receivers," by A. H. B. Walker. At a suitable operating point a selenium rectifier has a much lower a.c. resistance than d.c. resistance. The latter governs the bias voltage developed across it when it is in the cathode circuit of a valve but the a.c. resistance governs the amount of negative feedback. It is, therefore, possible to use cathode bias with much less degeneration than would be possible using an ordinary resistor. Its application is, of course, to cases where it is impracticable to use a cathode bypass capacitor and one example is the video stage of a television receiver, which may take the form sketched in Fig. 2. In a typical case the a.c. resistance may be only 70 Ω for a d.c. resistance of 295 Ω. The a.c. resistance varies considerably with current. Unless the signals are restricted, therefore, the feedback will vary with signal amplitude and give a non-linear response. This may, or may not, be disadvantageous, but it must be taken into account in the design.

The question of the proper intermediate frequency for television was discussed in the paper by D. H. Fisher, P. A. Segrave and A. J. Watts, "The Design

[1] "Interlacing", by W. T. Cocking, *Wireless World*, April 1947, p. 124. Editorial, *Wireless Engineer*, May 1951, p. 131.

of a Superheterodyne Receiver for Television." The conclusions reached are that the vision carrier frequency should be at 35 Mc/s and the sound at 38.5 Mc/s. In this connection it is interesting to recall that frequencies of 34 Mc/s and 37.5 Mc/s respectively were suggested three years ago as being the most suitable,[1] and there has recently been talk of using 34.5 Mc/s and 38 Mc/s.

This paper also describes three- and four-circuit filters for vision-channel i.f. couplings. With their aid very steep skirts to the response curve are obtained and it is possible to do without sound-channel rejectors. The discussion is eminently practical and is well illustrated by oscillograms showing the types of response obtained during alignment. The use of a wobbulator for alignment would appear to be essential with these circuits.

A typical arrangement is shown in Fig. 3. The first and last circuits L_1 and L_4 are tuned mainly by the valve capacitances, while the other pair L_2 and L_3 have capacitors C_1 and C_2; L_1 and L_2 are coupled by mutual inductance as are L_3 and L_4. A tapping on L_2 is connected to a coupling coil L_{2a}. It is important to avoid stray capacitance coupling and to arrange that the dust cores used for trimming do not appreciably alter the couplings.

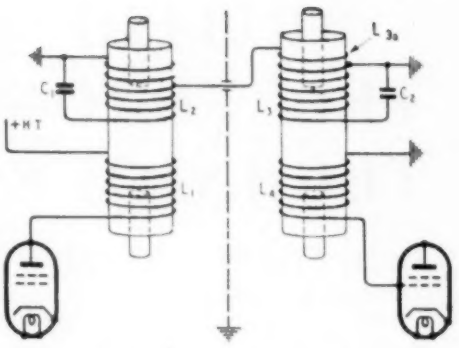


Fig. 3. Four-circuit bandpass filter.

Cathode-Ray Tubes

In the section dealing with valves one of the most interesting papers was one describing the development of an electrostatically-focused cathode-ray tube. Such tubes are not in essence new—at least one type was in use before the war—and there is a trend towards them in the U.S.A., largely in order to save the copper needed for an electromagnet or the cobalt required in a permanent magnet. Modern development in the electrostatically-focused tube is to retain magnetic deflection, to incorporate an ion trap, and to keep the potentials needed by the extra electrodes below 250 V so that they can be obtained from the receiver h.t. supply.

Work is being done on the development of a fixed-focus tube in which the focus electrode is joined to the cathode. With a 1st anode potential of 250 V, such a tube is feasible if operation of the final anode is at over 12 kV, but it seems that below 10 kV a focus control will be desirable.

Interference

The paper by A. J. Biggs and E. O. Holland on "The British Television Receiver" is noteworthy as giving a good account of the typical present-day British practice without excessive detail. A point of interest in the Appendix to it is the statement that double-sideband operation (e.g., double-sideband reception of Alexandra Palace) has been found superior to vestigial-sideband operation in fringe areas. Not only is noise less, as one would expect, but external interference gives rise to effects of shorter duration because of the greater bandwidth of the receiver.

A. J. Biggs and R. A. Mills presented a paper "The Performance of Television Receiver Installations in the Presence of Interference." The interference considered is that carried by the supply mains wiring of the house in which the receiver is installed. The paper describes an elaborate series of tests carried out with various television receivers under standard conditions. These tests showed that the use of twin aerial feeder tends to result in a higher level of interference than coaxial feeder as these feeders are at present used in average sets. In the worst sets tested, coaxial cable was 8 db better than twin and in the best sets 19 db better; however, the worst set with coaxial was 15 db worse than the best set with twin feeder.

It would be wrong to conclude from the tests that coaxial cable is, even on the average, inherently better than twin feeder. It is far less a matter of the cable used than of its termination and the relatively poor results obtained with many sets fitted with a twin feeder are due much more to the lack of a proper balance-to-unbalance transformer in the receiver than to the feeder itself. The large variations found with coaxial feeders are to be ascribed to the cable terminations. The bonding of the cable outer to the chassis is especially important and raises serious difficulty in transformerless sets where the chassis is live to the mains.

Cinema Equipment

In complete contradiction to the normal methods of synchronizing the receiver time-bases, the system which has been developed primarily for cinema television is extremely elaborate. Described in a paper by A. W. Keen, "A Precision Synchronizing System for Large-Screen Television Equipment," it is based on a form of fly-wheel circuit in which a multivibrator is kept in step with the line sync pulses by comparing the two signals in a phase discriminator and generating an error signal to control the multivibrator. A most unusual feature is that the frame scan is derived locally from the line waveforms and without any reference to the frame pulses in the received signal. Two things result from this. One is that the fly-wheel circuit is effective for the frame scan as well as for the line; the other is that it is possible to have an adjustable control of the precise timing of successive frames and, hence, of the interlace. As so far developed, the system seems much too elaborate for use in domestic receivers, but the paper is full of ideas, some of which might well find application to them.

[1] "Television Station Selection", by W. T. Cocking, *Wireless World*, July 1949, p. 242.

BRITISH TELEVISION TECHNIQUE

Papers Presented at the Recent I.E.E. Convention

THE Institution of Electrical Engineers has just done a very good thing for radio engineers in holding a Convention on what it modestly calls "The British Contribution to Television." Not only because the event has publicized the considerable British achievements in this field, but because it has brought into the light of day a large amount of technical information that would otherwise have remained in the dark recesses of filing cabinets and engineers' brains and been no use to anybody.

The Convention was held in London during the week beginning 28th April, and over a thousand delegates attended. Most of us, however, will have to be content with just reading the papers afterwards—not that there is any disadvantage in getting the information second-hand in this way, because at the Convention the authors only had time to give very brief summaries of their papers (which were prepared in advance), and the verbal discussions were necessarily somewhat sketchy compared to what they will be in the final printed form.

Over eighty papers were presented, in ten sessions. Each session centred around some particular aspect of television, and consisted of a survey paper followed by a number of more specialized supporting papers. In this way almost the whole field of television was covered, and there were very few omissions for such an ambitious scheme. Of course the papers were mainly concerned with present-day techniques, but one was devoted to the history of television development from the 19th century up to 1936. It only dealt with systems, however, and did not concern itself with the radio communication side.

Broadcasting and Reception

Television broadcasting stations and transmitters were surveyed very adequately, high-power transmitters being described in detail, and the old problem of whether to modulate at low level or at the output stage was brought up for discussion. Useful information was given on the design of transmitting aerials for common vision and sound working, and on suitable circuits for combining the two transmissions. There were expositions on wave propagation at television frequencies and the effect of the ionosphere, and an explanation was given of how sites for new transmitters are selected and tested.

There was a good deal of general information on the design of commercial receivers, with particular emphasis on receiving aerials, interference, interlacing, frame-scan circuits and deflector coils. A "preferred" range of valves for a.c./d.c. sets was suggested in one paper, while others showed how it was possible to make use of germanium and metal rectifiers in receiving circuits. More could have been included here, but then, of course, receiving technique is a very big subject.

Coming to the "glassware" used in television, the design, manufacture and life testing of cathode ray tubes were dealt with quite fully, and there was a description of a c.r.t. electrostatic focusing system. On valves there was a review of progress in the design and manufacture of receiving types from 1935 onwards, with some rather more specialized information on the development of reflex klystrons and coaxial-line oscillators for centimetre-wave radio links. Camera pick-up tubes and monoscopes were not forgotten.

The engineering aspects of programme production were surveyed very comprehensively, with discussion on the problems of studio lighting and the sound side. Design of cameras and associated equipment was also dealt with. Film came into the picture rather prominently with descriptions of film scanning and television recording equipment, and there was an interesting account of how the television camera can be used to advantage in film-making.

The business of conveying television signals from place to place was represented by descriptions of portable centimetre-wave radio links and a whole mass of information on coaxial cables and their associated equipment. There was also something on the system of television distribution by wire used at the moment for towns which are outside the service areas of transmitters.

Closed-Circuit Television

The array of non-broadcasting television applications in industry, commerce and scientific research was most impressive and pointed to the growing importance of this field. Full descriptions were given of a television system for demonstrating surgical operations and a flying-spot microscope. Certain aspects of large-screen projection television for cinemas were also included.

Most of the test apparatus described was for testing transmission channels, such as radio links and coaxial cables, for non-linearity, phase distortion and other forms of distortion.

Several papers gave a glimpse of possible future trends in television. The more fundamental and subjective aspects of colour television were reviewed, brief mentions were made of higher definition and stereoscopy, and there was a discussion on the possibility of compressing television signals to save bandwidth and ether space.

Single papers can be obtained from the I.E.E. at 1s 3d each, while a set for one session costs 8s, and the complete set for the whole Convention is £3 5s 3d; members can get them at lower prices. The papers will also be published in four special issues of the I.E.E. *Proceedings* (Part IIIA), with the discussions included.

Apart from the technical sessions, the Convention included a number of visits to firms and to B.B.C. and Post Office establishments. In the way of social functions there was an inaugural luncheon, a dinner and ball at the end, and a conversazione, given by the Radio Industry Council, at which manufacturers displayed a selection of their equipment.

Television Receiving Aerials

I—Characteristics of Simple Dipoles, Directional Systems and Requirements for Good Reception

By F. R. W. STRAFFORD,* M.I.E.E.

In preparing this article the author has made use of some of the information and diagrams in his paper "Receiving Aerials for British Television" which was read at the recent I.E.E. Television Convention, and is to be published as Paper No. 1287R in the *Proceedings of the Institution of Electrical Engineers*, Part 3A.

OUR knowledge of the dipole aerial for short-wave reception (or transmission) extends back for at least a quarter of a century. Eminent mathematical physicists have published numerous papers explaining why the exact mathematical theory is impossible which, at first sight, seems amazing having regard to the simple geometry of this elementary self-resonant collector (Fig. 1a).

Each physicist proceeds on the basis of acceptable compromises, and each deduces his impedance formulæ by the employment of independent, and sometimes ingenious, artifices. Their results agree very closely, but the dipole is analysed in every instance in idealized circumstances, in which it cannot be used! For example, a quarter-wave unipole is placed over an infinitely conducting and extending earth plane, or a half-wave dipole is placed at an infinite distance from the earth. In addition, no connection is made to the lower tip of the quarter-wave unipole, or between the two innermost tips of the half-wave version.

Hence, it is impossible to check the accuracy of any of these formulæ for the simple reason that it is necessary to bring the aerial near to an earth plane of finite conductivity and connect it to the measuring device by means of a suitable transmission line.

One can, in a practical way, make some realistic assumptions as to what is likely to happen. By virtue of its distributed L, C and R (Fig. 1b) the dipole is a very incompact tuned circuit possessing a low Q factor. It is well known that the Q of a normal lumped tuned circuit is reduced when it is brought into close proximity with other conducting objects, so there is every reason to suppose that the dipole should be similarly affected by the earth, and also by the connecting feeder if the latter is not balanced.

The vertical dipole possesses a considerable degree of symmetry which is largely destroyed when the feeder lies parallel to its lower element, but on practical and æsthetic grounds this is unavoidable.

Dipole Characteristics.—The term "dipole" will be used to describe the resonant half-wave dipole which, although precise, makes tedious repetition.

The radiation resistance referred to the centre terminals AB (Fig. 1a) is, theoretically, 72 ohms when the diameter, d, is infinitely small, but falls only slowly as the diameter is increased. For any dipole in the British television channels, diameters up to 1 in will introduce a negligible variation. The proximity of the feeder, and the effects of the earth and surrounding objects, have a far greater effect, with the result that the resistance will generally lie between 50 and 90 ohms.

Matching a Dipole to a Feeder.—A feeder in common use for television aerial installations is of coaxial

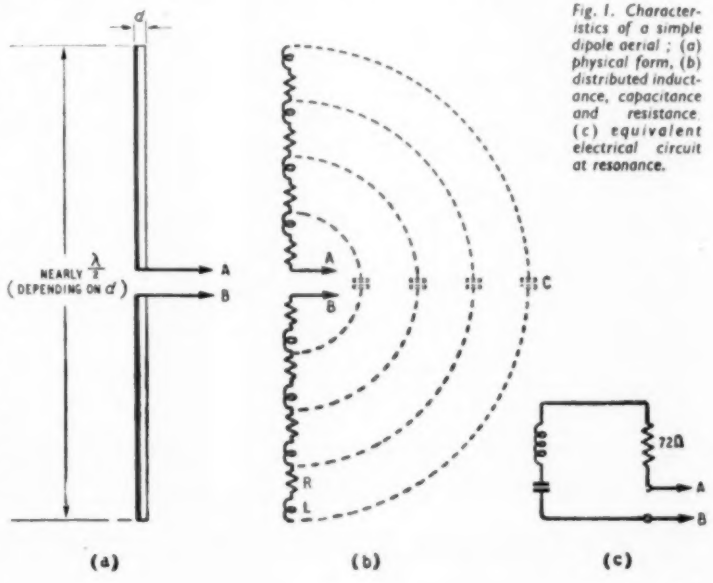


Fig. 1. Characteristics of a simple dipole aerial; (a) physical form, (b) distributed inductance, capacitance and resistance (c) equivalent electrical circuit at resonance.

* Belling & Lee Ltd.

construction. A popular type employing a solid polythene dielectric has a loss of about 3.5 db per 100 ft, while a semi-air-spaced version possesses approximately half this loss and is usually employed for long runs, or where the signal is weak initially. Twin-balanced and shielded twin-balanced feeders are employed also.

If their route passes through local interference fields a high signal-to-noise ratio is obtainable with either type provided the coaxial feeder is joined to the aerial by an unbalance-to-balance section, and the twin feeder is connected to a carefully balanced input circuit at the receiver.

There is much misconception concerning the importance of impedance matching of television receiving aerials. This misconception probably arose from wartime experience of radar aerials. A single radar aerial usually performs both transmitting and receiving functions, but its electrical design is dictated by the more stringent requirements of transmission.

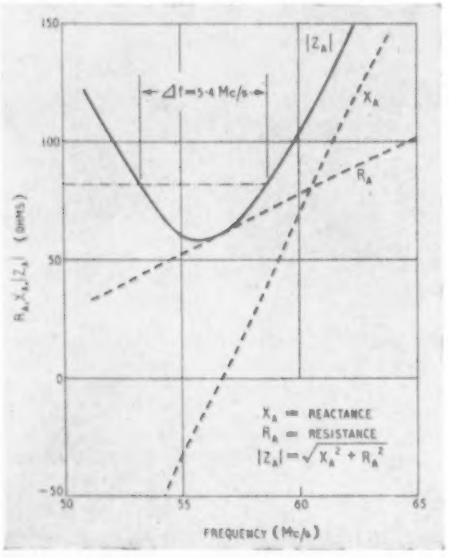
In high-power television transmitters the aerial design requires even greater care than is given to radar aerials. High-power transmitters cannot accept mismatched loads because of the dangers of voltage breakdown. There is an additional problem which involves very accurate matching at the aerial and the transmitter. On account of the length of the feeder (several hundred feet) and its very low attenuation losses, small mismatches at each end will result in multiple delayed images due to reflected waves along the feeder.

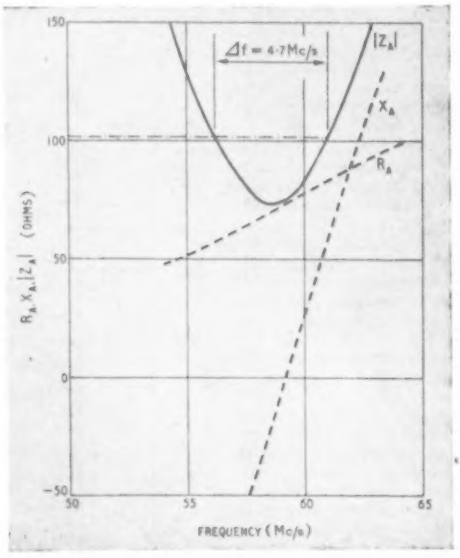
In the case of television receiving aerials, these problems do not arise. It is well known that maximum power transfer from a generator of finite resistance occurs when the load and generator resistances are equal. If a curve relating load power to mismatch ratio is plotted it will be apparent that there is considerable latitude. For example, a mismatch of 2 to 1 will cause a loss of only 0.4 db and a mismatch of 4 to 1 a loss of 2.0 db.

The inherent attenuation losses of feeders encountered in the average receiving installation are generally greater than the losses which will arise from inaccurate matching. The average length of feeder installed in a suburban two-storeyed residence, where the aerial is erected on the chimney stack, is about 40 ft. A solid-dielectric feeder of the type described will introduce a loss of 1.5 db, so that little is to be gained by attempting to match an aerial with a resonant impedance of 40 ohms to a feeder of 80 ohms. Theoretically the gain would be 0.4 db, but a matching device may not be fully effective because of its own losses. When maximum aerial efficiency is required it is better to select feeders with lower losses than to attempt closer impedance matching.

Folded Dipoles.—The folded dipole may be regarded as a combination of a simple dipole and transmission line. The impedance at the points of connection is of the order of 300 ohms and the bandwidth is greater than that of the simple dipole. It will be seen later that the bandwidth of the simple dipole is more than adequate, so there seems to be little purpose in wasting precious raw material, bearing in mind that one folded dipole contains sufficient material to make *two* simple dipoles. The greater bandwidth of the folded dipole will introduce higher levels of adjacent channel interference, and in any event a transformer will be required to step down the feed impedance (300 ohms) to the conventional 80-ohm feeder.

It may be argued that the folded dipole serves a useful purpose when combined with parasitic elements as an array. It certainly raises the feed impedance and eliminates the need for a quarter-wave matching





Left: Fig. 2. Calculated impedance characteristics of a television channel-4 dipole made of $\frac{1}{8}$-in. diameter tubing.
Right: Fig. 3. Calculated impedance characteristics of a channel-4 dipole made of No. 14 s.w.g. wire.

stub. But the matching stub can consist of a few feet of 40-50-ohm feeder and is cheaper than the additional elements required by the folded dipole. The foregoing evidence suggests that there is no case for it for British television of the present standard of definition.

On the other hand, the 819-line v.h.f. system operating from Paris and Lille requires folded dipoles, particularly for multi-element arrays, and such aerials are well in evidence among the growing number of installations to be seen on the Continent.

Multiple Images Due to Mismatching.—When the feeder is mismatched at each end, a series of evenly spaced "ghosts" of successively diminishing amplitude can occur, but it is very doubtful whether this arises in practice, for the following reasons. To be visible the ghost must be displaced beyond the normal visual circle of confusion. For example, assume that 60 ft of feeder is employed and that the dielectric is solid polythene; the first delayed image will arrive about 0.18 μsec after the original. For a 10-in picture width this corresponds to an image displacement of 1/50 in. The eye is not capable of resolving this into a second image, and at the worst it will merely cause a slight loss of definition at points of sharp contrast. In any case, to cause loss of definition in this way the strength of the reflected signal would have to be comparable with the original. The fraction of signal reflected by mismatch is given by $K=(Z_R-Z_0)/(Z_R+Z_0)$. On the assumption that the aerial and receiver impedance is 40 ohms, and the feeder impedance 80 ohms, the reflection coefficient calculated on this basis will be 0.33.

In the two traverses of the feeder (from receiver to aerial and return), the amplitude of the reflected signal will be one-ninth of the original. When converted to decibels, and added to 4 db, (the feeder loss), the overall attenuation of the ghost with respect to the original is 23 db. Ghosts may be produced artificially by splitting the output from a dipole and connecting one feeder direct to the receiver, while the other, a delay feeder, is connected to the receiver through a variable attenuator. The desired delay may be obtained by adjusting the length of the delay feeder. The amplitudes of the signals from the two feeders are at first equalized and attenuation is then introduced into the delay feeder until the ghost is removed. In a test of this kind it was observed that a displacement of about 0.1 in was necessary in order to resolve a ghost as a separate image, and that about 18 db in the attenuator removed it for any but the most discerning viewer. Attenuation of 24 db rendered the ghost indiscernible. The test was carried out on a commercial receiver of good performance.

To displace the image by 0.1 in the feeder length must be 300 ft. With a 2 to 1 mismatch at each termination, and normal feeder loss, the amplitude of the ghost will be 38 db below the original. It may be concluded that most installations will be free from ghosts arising from feeder reflections, and that if they are present it will generally be found that they are due to reflections from buildings, large structures, or hills in the vicinity.

Bandwidth of a Dipole.—In a lumped series-tuned circuit the bandwidth is defined as the total frequency band lying between the points at which the impedance is $\sqrt{2}$ times the minimum value. This is often referred to as the half-power bandwidth. There is no reason why the same definition should not apply to the dipole, although it might be better to refer to it as the intrinsic bandwidth. The loaded bandwidth, which is obtained when the aerial is correctly terminated through a feeder by a resistive load, will be equal to twice the intrinsic bandwidth.

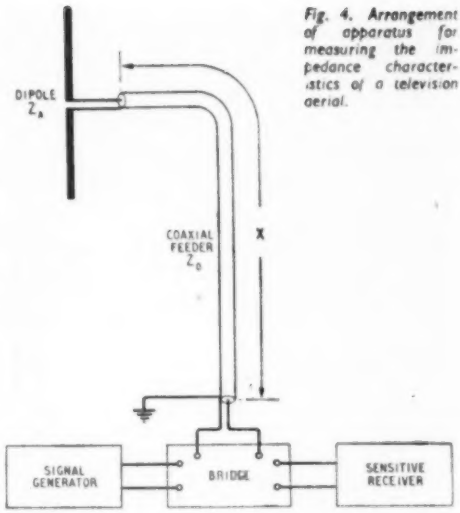


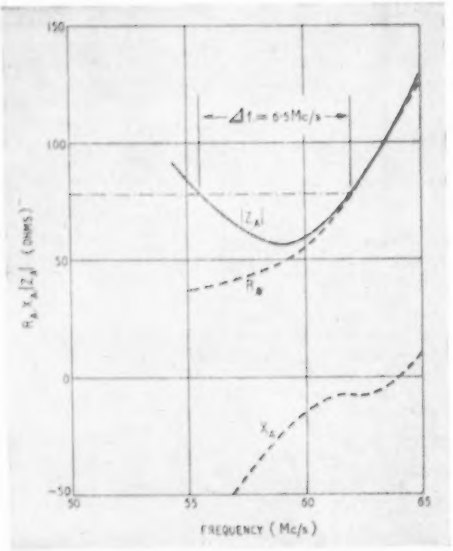
Fig. 4. Arrangement of apparatus for measuring the impedance characteristics of a television aerial.

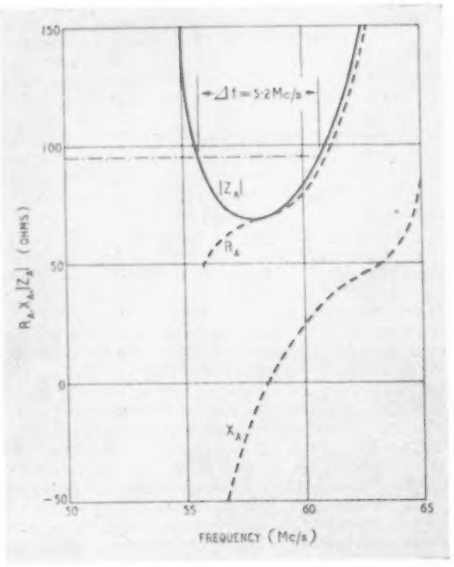
Formulæ developed by Schelkunoff[1] have been used to calculate the bandwidth of two dipoles. The first is constructed from 34 s.w.g. copper wire and can be regarded as a very thin-wire dipole. The other is constructed from ¼-in tubing, and both dipoles are cut to resonate in channel 4 (Sutton Coldfield). The curves are shown in Figs. 2 and 3, from which it can be seen that the calculated intrinsic bandwidth of the thin dipole is 4.7 Mc/s and that of the ¼-in dipole is 5.4 Mc/s. Hence, the loaded bandwidths are 9.4 and 10.8 Mc/s respectively. The loaded bandwidth of the thin-wire dipole is therefore far in excess of present requirements. It would be reasonable to enquire why fine wires are not employed commercially; such wires would have to be supported and the cost of the supports, including insulators for the remote ends, is greater than that of elements constructed from self-supporting tubes.

Measurement of Intrinsic Bandwidth.—There are several methods of measuring the intrinsic bandwidth of a television aerial and all of them have certain disadvantages. A cautious experimenter will encounter numerous and perplexing difficulties. The well-known slotted-line technique devised by Brückmann[2] is not practicable because of the length of precision line involved, which would be about 12 ft for channel 1. There is no doubt that a suitable line could be made, but it would require very careful design and involve extremely high manufacturing costs. One of the most reliable methods is to employ a high-frequency bridge, an example of which has been specially developed by the B.B.C. Research Department.[3]

The general arrangement is shown in Fig. 4 and it

[1] Schelkunoff, S.A. *Proc. I.R.E.*, 1941 V.29, p.493.
[2] Brückmann, H. *Hochfrequenztechnik*, 1938, V.51, p. 128.
[3] Calvert, R. *Electronic Engineering*, 1948, V.20, p.28.





Left : Fig. 5. Measured intrinsic impedance of a channel-4 dipole with ¾-in. diameter elements. Right : Fig. 6. Measured intrinsic impedance of a channel-4 dipole with No. 34 s.w.g. wire elements.

should be noted that the measurement of intrinsic impedance will include the effect of the coaxial feeder, and this must be removed mathematically. The procedure is laborious, but the calculations are considerably simplified by the use of the Smith[1] chart.

By this method the impedances of the ¾-in and 34-s.w.g. dipoles have been measured at a height of 23 ft. Figs. 5 and 6 depict these results and if compared with their theoretical counterparts (Figs. 2 and 3) it will be seen that the measured values of bandwidth exceed the theoretical by between 15 and 20 per cent. Fig. 7 shows the impedance moduli of the ¾-in dipole at three different heights. This slightly enhanced bandwidth is to be expected from the increased losses due to the proximity of the feeder and the earth, as pointed out earlier.

Directional Aerials.—It is often necessary to increase the signal energy supplied to the receiver, or reduce unwanted signals or noise arriving from directions other than that of the desired transmission. The addition of one or more correctly proportioned parasitic elements will assist in meeting this requirement.

The resolving power of a parasitic array of usable dimensions is very poor when compared with a reflecting telescope, which in most respects obeys the same laws governing television waves, since light is an electro-magnetic phenomenon.

To obtain a resolving power comparable with a simple 3-in reflecting telescope, a television channel-4 array would require a parabolic reflector some 450 miles in diameter!

The mathematical treatment of arrays containing a single parasitic element is very difficult and almost unmanageable for more than one. In any case, simplifying assumptions must be made which often provide an academic rather than an engineering solution. Hence, the development of directional aerials usually involves trial and error methods which may be laborious, and are largely affected by the weather. The apparatus shown in Fig. 8 was developed for reducing the time and effort involved in adjusting parasitic arrays. A frequency ten times that specified in the design is chosen and adjustable models of the aerial are constructed to a scale of one-tenth. The model is rotated slowly by means of a motor and is geared to a disc which carries a circular paper chart ruled in polar co-ordinates. The output from the model aerial is fed down the centre of the mast and applied to a terminating resistor of the disc type across which is connected a crystal rectifier circuit. The resultant d.c. output operates the servo-controlled pen which marks the directional response on the chart. The transmitting oscillator is a conventional tuned-line arrangement and care is taken to ensure that equal currents are supplied to the radiating dipole at each test frequency.

The radiator and model are placed about 14ft (seven wavelengths) apart on a concrete plinth about 6ft wide in which is embedded a close-mesh conducting mat, the purpose of which is to maintain constant ground plane conditions; early work indicating that this artificial earth was essential. During the initial experiments reflections introduced spurious responses and these were subsequently eliminated by locating the transmitting aerial within a corner reflector consisting of two brass sheets about 4ft high and 3ft in length set at 90 deg. The radiated power was increased as a result and the receiving rectifier then operated at a higher level, thus tending to linearize the output. It was necessary to control the rotating mechanism by a remote switch, otherwise the presence of a body near the apparatus gave rise to spurious responses.

Some very useful work has been carried out with

[1] Smith, P. H. *Electronics*, 1939, V.12, p.29.

this apparatus and the following conclusions are considered worth recording. Most of them confirm known theory: (a) A parasitic element whose length is shorter than the dipole acts as a director and must be spaced approximately 0.1 λ from the dipole to secure a maximum gain of about 5 db. (b) When a director is spaced approximately 0.05 λ from the dipole a high front-to-back ratio of about 26 db can be obtained, but this array is very sensitive to small dimensional changes and the feeder and supporting mast must not be in the plane of the elements. (c) If a director-type aerial is adjusted to provide maximum gain on a video-carrier frequency the gain falls considerably at the associated, and lower, audio-carrier frequency. (d) Arrays embodying closely spaced parasitic directors are very sensitive to spacing, and unless extremely rigid elements are employed considerable amplitude variation is observed in high winds producing picture brightness flutter of a very objectionable kind. (e) A parasitic element whose length is greater than the dipole acts as a reflector, i.e., reverses the directional response of the aerial. (f) When a parasitic reflector is employed the increase of gain with spacing is slow beyond 0.15 λ and attains its maximum value at about 0.25 λ. An aerial designed with 0.25-λ spacing is free from picture flutter. (g) A parasitic array designed for television reception must respond to both video and audio carrier frequencies; whilst it is usual to design for maximum performance on the video channel the design must not involve an appreciably lower gain on the audio channel. In the case of a two-element array a good compromise is effected by designing the dipole to resonate at the video carrier frequency, and the reflector at the audio carrier frequency, and spacing them one quarter of the arithmetic mean of the wavelength of the two carriers. (h) The two-element array specified in (g) will provide a forward gain of approximately 5.0 db and a front-to-back ratio of approximately 14 db. These measurements include the effect of the feeder which lies midway between the dipole and the parasitic element in the same plane. Previous workers have considered horizontal arrays in which the feeder and the supporting mast contribute little effect. The results obtained from vertical arrays must therefore differ appreciably from their horizontal counterparts.

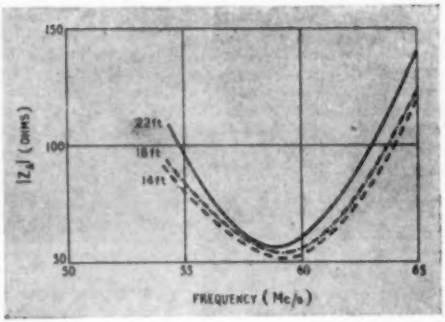


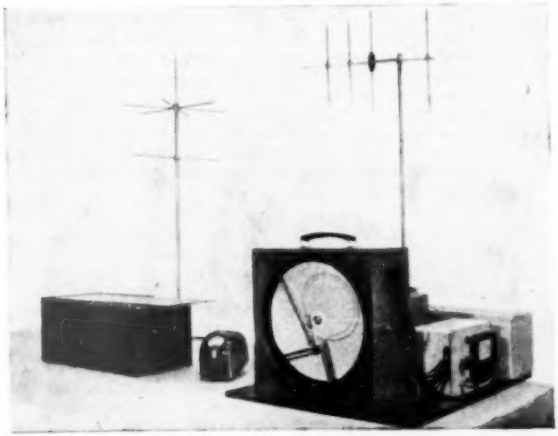
Fig. 7. Variation of intrinsic impedance of a dipole with $\frac{1}{8}$-in diameter elements at three different heights.

At the conclusion of the work on the miniature array a full-scale model may be constructed in such a way as to embody means for small adjustments to the element lengths and spacings above and below the optimum dimensions determined on the miniature model.

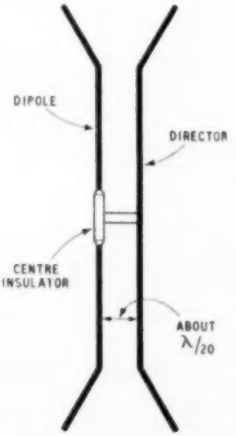
A useful variant of the H-type aerial is the well-known X which is, basically, an H with its waist "pinched." The spacing is substantially zero at the centre and $\sqrt{2} \times \frac{\lambda}{4}$ between the remote tips which gives it some hypothetical spacing determined by the current distribution and phases in the elements.

The X aerial possesses a somewhat higher front to-back ratio than the conventional H, but achieves it at the expense of slightly reduced forward gain, loss of directional characteristics on the sound channel, and greater susceptibility to brightness modulation caused by reflections from flying aircraft. Any aerial whose collector elements subtend a horizontal component will increase aircraft modulation.

Another variant of the H consists of one in which the dipole and parasitic element are spaced approximately 1/20 of a wavelength apart. When the elements are suitably proportioned (the parasitic element being



Left: Fig. 8. Simple apparatus for measuring gain and directional response of scaled-down model arrays.



Right: Fig. 9. "Crooked-H" aerial giving high front-to-back ratio.

a director) back-to-front ratios as high as 30 db may be attained. To overcome the picture brightness flutter occasioned by oscillation of the remote tips these are bent as shown in Fig. 9.† Since most of the coupling between the dipole and its parasitic element takes place where currents are greatest (in and near the centre) the bending of the tips does not seriously reduce the front-to-back ratio. It is essential that the array be supported by a cranked mast, so that neither mast nor feeder lie between the dipole and director elements.

† Patents applied for.

For "fringe" reception, in field strengths of the order of 50 μV/m, a four-element array probably represents the largest structure that can be produced and erected economically when relating it to the initial cost of the receiver. The cost of manufacture and installation rise very rapidly when further elements are added. Such an array may comprise a reflector spaced about 0.25 λ behind the dipole, and two directors successively spaced 0.1 λ in front. The forward gain is approximately 9 db and the front-to-back ratio is about 24 db.

(To be concluded)

BOUNDARY-DISPLACEMENT MAGNETIC RECORDING

IN conventional magnetic recording systems the magnetization characteristic of the material is involved in the modulation process, and high-frequency "bias" must be applied to reduce non-linearity arising from this source to practicable limits.

A method of recording in which the magnetic response of the material is not directly involved, is described by H. L. Daniels in the April, 1952, issue of *Electronics*. It is termed boundary-displacement recording, and can be used with standard commercial tapes. Although the fundamental magnetization is longitudinal, as in normal recording, the modulation is lateral and is obtained by displacement of the boundary between two zones of opposite magnetic polarity. These zones are uniformly magnetized to saturation, and the absolute intensity is immaterial, provided that it is equal on both sides of the tape. Fig. 1 (a) shows an unmodulated record with equal distances on each side of the central transition zone, while Fig. 1 (b) represents modulation by a sine wave. Magnetic conditions for equivalent states with conventional magnetic recording are indicated by Figs. 1 (c) and (d).

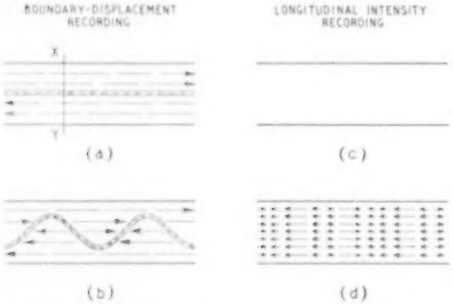


Fig. 1. Illustrating the difference between boundary-displacement recording (a) and (b) and conventional longitudinal intensity modulation (c) and (d).

A normal playback head is used for reproducing boundary-displacement recording, and the gap may be represented by XY in Fig. 1 (a). It will be seen that in this case equal and opposite magnetomotive forces are applied to the magnetic circuit and the pick-up coil output will be zero. When the boundary is displaced from the centre line there will be an excess of one or other polarity and an equivalent voltage output will be produced. The system is analogous to variable-area recording on film.

For recording, a special type of head is used, in which a stack of thin laminations with non-magnetic separators forms a line of individual gaps, in the direction of motion of the tape, with a separate integral polepiece energised by the signal coil. Magnetic bias is applied transversely to the laminations by a permanent magnet and the interaction between this field and the signal field at right angles, varies the point at which the neutral flux crossover point intersects the line of the gap (Fig. 2).

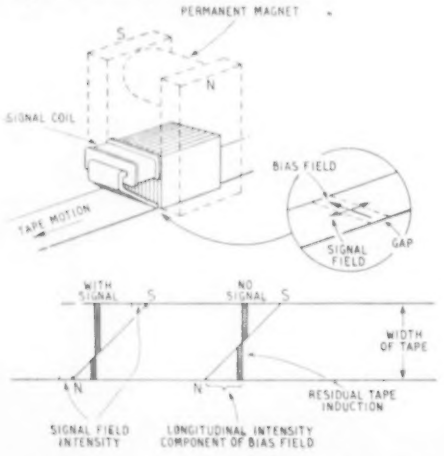


Fig. 2. Construction of recording head, and diagrammatic representation of combined bias and signal fields.

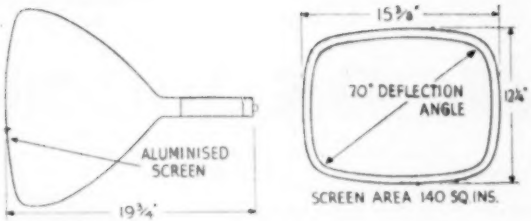
It is evident that a high degree of accuracy in the width of the gap and the distribution of flux in the polepieces is necessary to ensure linearity of response to amplitude variations, and it is an open question whether the transfer of the onus from the magnetic material of the tape to the geometry of the recording head will prove of practical advantage for audio-frequency recording. So far the chief uses of the new principle have been in recording and measuring high-speed transients, and in this application the fact that the full energy-storing capacity of the material is employed, is of particular value.

Now generally available!
Rectangular Wide-Angle BRIMAR Teletubes

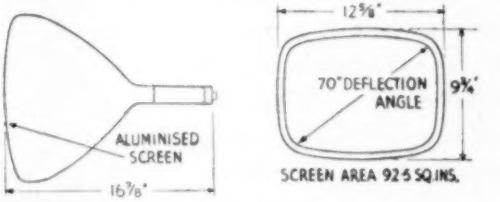
SET MAKERS in particular will be interested to know about these advanced Brimar rectangular, wide-angle Teletubes at present available in two sizes—the C 17 BM with a screen area of 140 sq. in., and the C 14 BM with an area of 92.5 sq. in. Both have aluminised screens and external conducting coatings.

Their rectangular construction permits the full screen area to be used and allows a considerable reduction in the depth and volume of cabinets.

NOTE. Because of the wide deflection angle and increased neck diameter of these tubes, ordinary scanning components cannot be employed.



C 17 BM
Heater Voltage 6.3V Heater Current 0.6A Anode Voltage 16kV nom
Cut-off bias —70V Modulation 30V peak (for 150 μA beam current)



C 14 BM
Heater Voltage 6.3V Heater Current 0.6A Anode Voltage 12kV nom
Cut-off bias —70V Modulation 30V peak (for 150 μA beam current)

Adequate E.H.T. and line and frame scan are provided by these valves for both the C 17 BM and the C 14 BM when operated from a 200 Volt HT rail in conjunction with high efficiency wide-angle scanning components.

VALVES for WIDE ANGLE LINE and FRAME DEFLECTION CIRCUITS

	6CD6G Line output tetrode	6U4GT Efficiency diode	12BH7 Frame osc. and output	1T2/R16 E.H.T. Rect.	R 12 E.H.T. Rect.
Heater Voltage	6.3 v.	6.3 v.	6.3 or 12.6 v.	1.4 v.	6.3 v.
Heater current	2.5 A	1.2 A.	0.6 or 0.3 A.	0.14 A.	0.09 A.
Peak Anode Voltage	6 kV	Peak Heater Cathode Voltage 3.85 kV	Amp. Factor 17	Peak Inverse Voltage 15 kV	17.5 kV
Peak Cathode Current	0.5 A.	Peak Inverse Voltage 3.85 kV	Impedance 5,500Ω		

BRIMAR VALVES and TELETUBES

Standard Telephones and Cables Limited FOOTSCRAY, SIDCUP, KENT

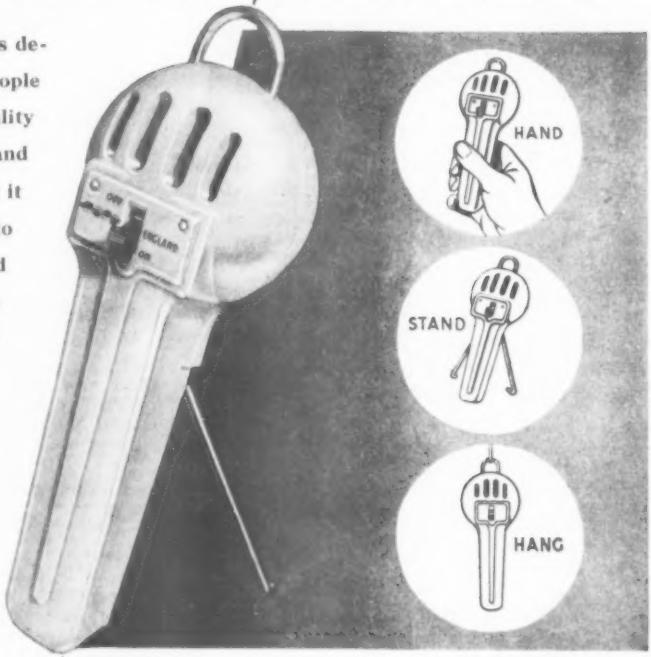
a fine quality

UNIVERSAL MICROPHONE

at a moderate price

acos MIC 30 'hand-stand'

This new Acos Crystal Model is designed to please most of the people all the time. It is a good quality hand microphone which will stand up or hang up when you want it to. The legs which convert it into a desk model are spring-loaded and fold unobtrusively into the attactive moulded microphone body when not in use. Frequency response is substantially flat from 50 to 5,000 cps, and an On-Off switch with provision to close an extra circuit is incorporated. The price is moderate at £4. 4. 0.



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LINE ELIMINATOR

"Spot Stretching" as an Alternative to Spot Wobbling

By G. N. PATCHETT,* Ph.D., B.Sc., A.M.I.E.E., M.I.R.E., A.M.Brit.I.R.E.

ONE annoying feature of television pictures is the presence of the lines, which are more pronounced on a receiver with good focusing than on one with a comparatively large spot. As the spot size is reduced the definition in the horizontal direction improves, so the spot is usually made as small as possible in order to give this definition. This "lininess" can be overcome by viewing the picture from such a distance that the lines are not visible, but in many cases this is more than the optimum distance and the horizontal definition is lost as the eye is no longer able to resolve the small detail in a horizontal direction.

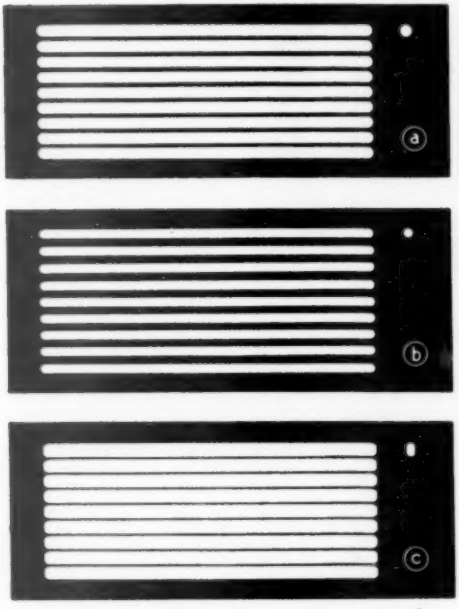
Unless the diameter of the spot is equal to the full width of a "line," a small black bar is left between adjacent traces of the spot as shown in Fig. 1(a) and (b), and it is the width of this black bar that is important. It is usually smaller than the diameter of the spot and hence small changes in the diameter of the spot cause large changes in the width of the black bar. Taking a 12-in tube with a picture height of 8in, since there are 377 active lines the space occupied by a line is $8/377 = 0.021$in, say 20 thousandths of an inch. If the spot is 14 thousandths wide then the black bar will only be 6 thousandths wide. If the spot is now reduced by twenty per cent to 11 thousandths, the width of the black bar is increased by fifty per cent to 9 thousandths and it becomes much more visible. In Fig 1(a) and (b) are shown two sets of lines drawn to these proportions, and it will be noticed that the lines are much more noticeable in (b). All this assumes perfect interlace, which does not appear to be commonly obtained in practice. If there is a certain amount of "pairing" of the lines the black bar is increased in width and the "lininess" is increased still more.

This "lininess" may be overcome if, instead of using a circular spot, the spot is made oblong in a vertical direction so that it just fills the space of one line. This is shown in Fig. 1(c) where the height of the spot is nearly equal to the width of a line; it will be noted that the lines are nearly invisible. If the width of the oblong spot is the same as the original diameter of the circular spot, the horizontal definition will remain the same or will be improved (see later).

One method of producing an oblong spot is by spot wobble† in which the spot is moved up and down at a frequency of the order of 10 Mc/s and so traces out a small vertical line. The method suggested by the author is not to move the spot up and down, but to focus it so that it is oblong instead of circular. This could be done by making the magnetic focusing coil so that it is not symmetrical about the centre of the tube and so only focuses in either a vertical or horizontal direction at one time—what is called astigmatism. But it is inconvenient to make the normal focusing arrangement unsymmetrical because of the difficulties of manufacture, and because no easy method would be available for adjusting the amount of asymmetry or removing it if not required. The author's idea is to place an auxiliary focus coil next to the normal focus coil or permanent magnet so that it assists or opposes the main focus system. The coil

* Bradford Technical College.

Fig. 1. Showing the effect of different spot sizes on visible line structure. In (a) and (b) the spot is circular while in (c) it is stretched to an oblong shape.



† *Wireless World*, March 1950, p. 84.

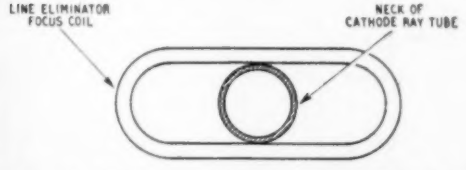


Fig. 2. Cross section showing the shape of the line eliminator focus coil in relation to the neck of the cathode ray tube.

is made oblong, as shown in Fig. 2, so that it has a greater effect in, say, the horizontal direction than in the vertical. If the current in the main focus coil is now adjusted it will be found that the spot comes to a focus as an oblong and not as a circular spot. In practice it has been found that the coil should not be horizontal or vertical but placed at about 45 deg, presumably because of the rotation of the electron beam as it travels through the focus coil. It is not certain whether this angle holds for all tubes, but the author has found it to be right for three tubes of different manufacture. Photographs of vertical and horizontal lines produced by the arrangement are shown in Fig. 3. Here the amount of alteration in spot shape is more than would be required in practice.

The best place to fit the coil is between the focus coil, or permanent magnet, and the deflector coils, as there is usually enough space there for a small coil of this shape. The number of ampere-turns required will depend to some extent on the tube and the exact position of the coil, but 50 ampere turns has been found to be more than sufficient. The coil can conveniently be placed in the h.t. line of the set with a variable resistor of 50 to 100 ohms in parallel, so that the magnitude of the "drawing out" can be controlled and cut out if required. The coil should be by-passed by a capacitor of, say, 50 μF (12-volt working usually being sufficient), so that no alternating components pass through it. A coil of 250 turns carrying 200 mA has been used by the author.

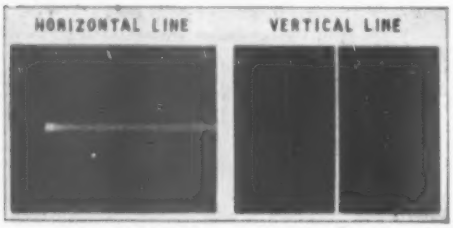
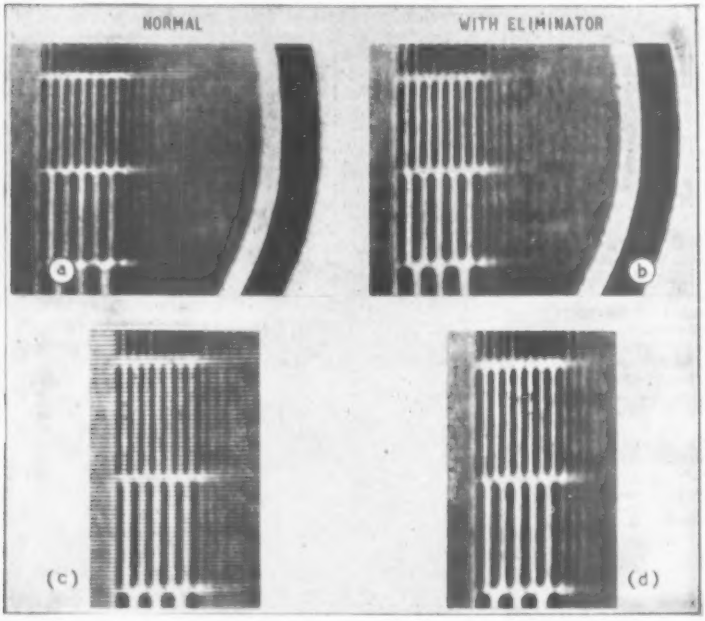


Fig. 3. Photographs of vertical and horizontal lines produced with the line eliminator in operation.

Fig. 4. Photographs showing the effect of the line eliminator on B.B.C. Test Card C. In (a) and (b) the picture is of normal size while in (c) and (d) its height has been increased about fifty per cent.



With the line eliminator in action, one must not focus on the lines (as is usual on a normal set) but on the horizontal definition. This is fairly easy on the B.B.C. Test Card C or on the tuning signal, but not as easy on an actual picture. One way is to focus on the lines with the line eliminator out of action and then increase the resistance in parallel with the coil until the lines just disappear. The setting is now nearly correct but not exactly so, as the coil does have some effect on the focus in a horizontal direction. The ideal way is to turn the deflector coils at right angles and then to focus on the lines with the line eliminator in action (when it will be found that the lines can be made as sharp as usual) and then turn the deflector coils back to normal without altering the focus. This is obviously not very practical where there is a focus control which can easily be moved, but it is quite feasible with permanent-magnet focus arrangements where the focus is set and not adjusted over long periods.

Some results taken on Test Card C are shown in Fig. 4; (a) and (b) being taken with normal picture size and (c) and (d) with the picture height increased about 50 per cent. Each pair is taken with exactly the same contrast and brilliance setting and the exposures were identical. The photographs were taken on a commercial receiver fitted with a 12-in tube operating near the centre of a city. Note that the horizontal definition is not impaired but is actually improved, the vertical bars being clearer in (b) and (d) than in (a) and (c). This can also be seen in Fig. 1, where the vertical edge is more distinct in (c) than in either (a) or (b).

The device also increases the contrast, as can be seen on Fig. 4. This is explained as follows: Suppose the normal spot is half the width of a line (and remains of constant diameter); in a black portion of the picture the whole area of the screen is black, but in a white portion only half the screen is white since the space between the lines is black and the area appears grey. When the line eliminator is in use the whole of the area is white in the white portion

of the picture and, of course, the whole area is black in the black portion.

The vertical definition may not appear from the photograph to be as good. In theory, so long as the spot is uniform over its height and does not exceed the line width the vertical definition should not be different (see Fig. 1(c)), but in practice the spot is not quite uniform over its height (neither, of course, is a circular spot uniform over its diameter), and in these photographs the amount of line elimination has been increased so as to completely remove the line structure when viewed close up, and this, no doubt, causes some overlap of the white bars. In practice the amount of line elimination required is much smaller in order to make the lines quite invisible at, say, 3in away, and there is no point in increasing it farther. The amount that it is required to stretch the spot vertically is quite small, as can be seen in Fig. 1, the height of the spot in (c) being only 170 per cent of its width, i.e., the spot is only increased in height by 70 per cent. When the line eliminator is used so as to cut out the line structure at any normal viewing distance it is very doubtful whether there is any loss in vertical definition.

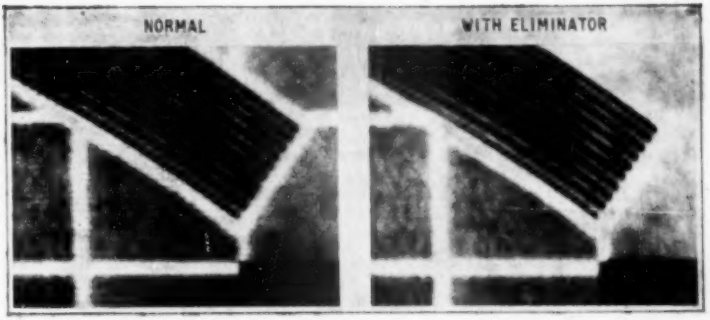


Fig. 5. Showing the effect of the line eliminator at the corners of B.B.C. Test Card C.

This scheme of line elimination has the advantage over spot wobble of being extremely simple and cheap. The total cost is only a few shillings and it can be fitted in a few minutes to most receivers. It also has the advantage that there is no possibility of interference from radiation, which appears to be a possibility with deflector coils operating at 10 Mc/s unless care is taken in the design. The device has been tried out on two commercial receivers of different manufacture and also on a receiver constructed by the author, and it has given equally good results on all of them. Most people who have seen the device in operation have stated a preference for the picture with the lines eliminated.

SUBMARINE TELEVISION

SINCE the successful use of television for the identification of the wreck of the submarine *Affray*, which had been located by acoustic means, considerable improvements have been made by the original manufacturers (Marconi's)*, and the Royal Naval Scientific Service has undertaken extensive trials with this and other equipment in an endeavour to evaluate the scope and limits of underwater television.

Demonstrations were given during the recent I.E.E. Convention of Marconi and Pye equipment, both of which are now being used experimentally by the Admiralty. A third type of camera—supplied by E.M.I.—is being used by the Scottish Marine Biological Association.

The cameras at first employed were modified versions of broadcasting equipment and, as such, are far more elaborate than is necessary for closed-circuit working. The increasing demand for simplified equipment for a wide range of industrial and research purposes will undoubtedly result in the production of more compact and simpler gear. The provision of the necessary watertight housing is not considered a formidable undertaking by the R.N.S.S., and two or three types of case have already been produced capable of withstanding water pressure up to 1,200 lb per square inch.

In a recently issued Admiralty Research Laboratory report, W. R. Stamp outlines not only the problems involved but the possible applications of underwater television. The direction of salvage work and the inspection of ships' hulls immediately spring to mind. Its main advantages in wreck survey are that it is capable of working at greater depths and for longer periods than a diver, even if an observation chamber is used; the findings are presented direct to those directing operations which facilitates manœuvring when using salvage grabs, etc., and, of course, there is no risk to life.

The study of marine life in its natural habitat and the use of television in oceanographic research are two further possible applications.

The latest camera, made by Pye, working in co-operation with the Admiralty, has a servo-operated, remotely-controlled focus system which, together with the remotely-controlled motor-operated four-lens turret, allows precise optical adjustment to be made at the control unit on board the deep-diving vessel. The vision signal is conveyed to a 14-in monitor tube at the control position.

One obvious advantage in the use of television is that a film record can be taken of the image received on the monitor, thus providing a permanent record of the investigation.

The camera is housed in a cylindrical case about 20in diameter and 30in long, to which is fitted a hood to carry the lighting. By increasing the diameter of the lens window in the housing to 5½in it has been possible to use a 1¾-in focal length lens, which increases the angle of vision to some 40°.

* See May issue, p. 205.

NOISE

Concluded from page 202 of the previous issue.

2—Practical Effects

By "CATHODE RAY"

FIRST a quick recapitulation of last month's instalment. The only kind of noise being considered is that due to (1) the jostling of electrons in conductors (Johnson or thermal noise, which is there whether current is flowing or not), or (2) the granular nature of valve anode current (shot effect). Such noise sounds very much like gramophone "scratch" or escaping steam, and its power is distributed evenly over all frequencies—not just the audible ones. (1) is proportional to absolute temperature T (i.e., centigrade + 273), and is based on Boltzmann's constant $k = 1.38 \times 10^{-23}$. The noise power, within the frequency band B, generated in any resistance and passed on to an equal resistance connected in parallel, is kTB. Since the voltage of any generator that puts P watts into a matched load R is $2\sqrt{PR}$, the Johnson noise voltage E_N is $2\sqrt{kTBR}$. (2) is based on the amount of electricity in one electron, $e = 1.59 \times 10^{-19}$, and is proportional to the anode current, but the exact fluctuation component of current depends on various conditions and it is only for saturated diode conditions that there is a simple formula — $I_N = \sqrt{2eI_aB}$. With the resistances and bandwidths commonly used in amplifiers, E_N is usually between 1 and 10 microvolts, and the noise voltages due to passing I_N through a coupling resistance are of the same order or rather less. The shot noise of a valve is specified as the resistance which, at the input of a noiseless but otherwise similar valve, would give rise to the same noise.

Whether or not electron noise is important in any particular case depends on how much signal strength is available. If it is at least several millivolts, there is no need to worry about noise at all. But where, as in radar, the idea is to detect the smallest possible signal, noise is all-important, for it is what ultimately limits range.

Rescuing the Signal

The cause of the noise is universal and unstoppable, and every source of signal is bound to be a source of noise; so one can only arrange things to obtain the maximum signal/noise ratio in the circumstances. When that has been done, and still the signal is so weak that it is lost in noise, no further amplification can do any good. The limit has been reached. One obvious way of arranging things is to see that the bandwidth accepted by the amplifier is no more than is needed to bring in as much of the signal as is necessary. Then there are various devices for enabling radar and telegraph signals to be read even when they are weaker than noise. Pulse code modulation* is a dodge for improving telegraph signal/noise ratio. The "just-readable" standard is hardly acceptable for broadcasting, however! That is where the claims of frequency modulation come in.

Suppose now we study the noise situation in different types of set. A simple one to begin on is a microphone amplifier. The source of signals consists of the microphone, usually connected to the amplifier through a transformer. The transformer can be considered either as part of the microphone or part of the amplifier. I am going to include it with the microphone. Then, if the transformer is regarded as perfect, the resistance of the microphone can be multiplied by the square of the transformer ratio to give the resistance of an equivalent microphone directly connected to the amplifier, with no transformer (Fig. 1). Reactance rather complicates matters, so for the purpose of this elementary discussion we shall assume that the impedance of the microphone is all resistance. If the microphone resistance were 1kΩ, and the transformer ratio 1 : 6, the equivalent directly connected microphone would have a resistance of $1 \times 6^2 = 36\text{k}\Omega$.

Another assumption we are going to make is that the input of the amplifier has an infinite impedance. If the first valve were a triode, its Miller effect would see that this condition was nowhere near fulfilled, but we suppose it to be a properly screened pentode. And, being an audio-frequency job, the amplifier is free from those v.h.f. effects that lower a valve's input impedance.

These two assumptions having been made, we know the r.m.s. noise voltage (or at least that part of it coming within the frequency band of the amplifier) at the input to the amplifier. It is $2\sqrt{kTBR}$. Suppose that B is 15,000 c/s, and R (the resistance of the microphone effective at the amplifier input) is 0.1MΩ. Then with T at its usual 290° the noise voltage would be just short of 5μV. If the requirement is for the weakest microphone signal to be, say, 40db above noise (i.e., 100 times its voltage) it must be at least 500μV. The microphone maker, if he knows his job, will have specified the strength of sound needed to produce a stated microvoltage, so we would know how strong the weakest sound would have to be at the microphone to ride above Johnson noise caused by the microphone resistance.

And here we see one reason why really high fidelity is difficult to achieve. To have a flat characteristic over the full audible frequency range, the microphone must be free from resonance over that whole range, which means that its diaphragm has to be small. Another reason for making it small is to ensure that parts of it are not hit simultaneously by opposite half-cycles of even the shortest (i.e., highest frequency) sound wave. All this means that the sensitivity is almost bound to be very low. Extending the frequency range from, say, 5,000 to 15,000 c/s brings in important but relatively very weak "signals"—the harmonics

* "Tens or Twos?" Sept., 1951.

that give clarity and faithfulness to the reproduction. But it also multiplies the noise power by 3. Another requirement for high fidelity is a full dynamic range—the system must deal with programmes having a very wide ratio of loudest to softest. All this being so, the weakest signal is very weak. So really high fidelity and at the same time freedom from noise is something to wonder at.

The fact that noise is equally powerful at all frequencies doesn't mean that it is equally loud. The loudness depends on the sensitiveness of one's ears, which is much less at low frequencies than at high. And since the frequencies above one or two thousands normally carry little of the power of the programme, cutting them down with a tone control reduces noise far more than signal, giving the impression that nearly all the noise is at that end. (Incidentally, this applies also to gramophone scratch, which although different from electron noise in origin gives the same sort of result.)

But we are getting rather off the point, which is to consider how the amplifier affects the signal/noise ratio. Thanks to our assumption that the signal source is connected straight to a first valve having infinite input impedance, no Johnson noise is introduced by the amplifier at its own input. And as we are pretty safe in assuming a gain of at least 10 times in the first stage (and probably much more), we can neglect any second-stage noise. That leaves only shot noise in the first valve to consider. As we know, it is not straightforwardly calculable like Johnson noise, so to make things as easy as possible for designers the valve makers specify the "equivalent noise resistance," which they denote by R_{ee}. But don't be misled by "resistance." It is as if the intensity of rainfall were measured in miles per hour, that being the speed of wind that would cause the same amount of rustling in the leaves. R_{ee} is no more a real resistance than rainfall is a wind. The reason for this roundabout approach is the difficulty of comparing the amounts of shot noise and Johnson noise in an amplifier if each is specified in its own terms. It is easy to compare them if shot noise is specified as the resistance between grid and cathode that would produce the same result by Johnson effect. In a low-noise pentode, R_{ee} is usually less than $2k\Omega$, so if the source resistance is at least $20k\Omega$ one can reckon shot noise is unimportant. (Noise voltage at the grid being proportional to $\sqrt{R}$, and power being proportional to voltage-squared, noise power is proportional to resistance.) So any noise put out by this type of amplifier is almost entirely due to the resistance of the signal source; there is no excuse for the amplifier itself contributing anything worth mentioning.

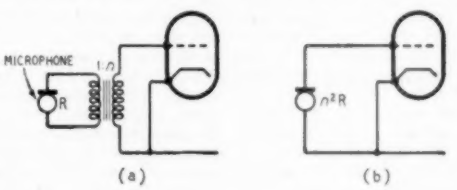


Fig. 1. For purposes of circuit calculation, a microphone or other signal source (a), having a resistance R connected to the amplifier by a perfect 1 : n transformer, is equivalent to a directly connected source (b) giving n times the signal voltage and having n^2 times as much resistance.

Next, we consider radio receivers. These may raise some queries about bandwidth. Broadcast receivers are designed to work on a bandwidth of twice the top audio frequency reproduced, in order to cover both sidebands of the transmitter. So they pick up twice as much noise as they would for the same audio band if they worked on the single sideband system used for radio telephone communication. Noise received along with both sidebands is transferred to the audio band by the detector. If the same transmitter power were concentrated into one sideband, and the receiver bandwidth halved accordingly, noise would be halved.

Noise from a Tuned Circuit

Up till now we have been assuming that the factor R in the basic noise formula—the resistance of the noise source—is the same at all frequencies, or at least all the frequencies accepted by the amplifier. But the input circuit of a receiver is normally a tuned circuit, and what is its resistance so far as noise is concerned? Is it the loss resistance, reckoned in series with the inductance and capacitance, and changing fairly slowly with frequency? Or is it the dynamic or equivalent parallel resistance, which is very high exactly at resonance and falls off sharply each side?

Actually it is the dynamic resistance that counts in the noise formula, so on a voltage reckoning this noise source itself has a limited bandwidth. But the bandwidth of a receiver sensitive enough for the noise to matter is practically certain to be much less than that of the first tuned circuit by itself, so there would be no need to worry about variation of dynamic resistance within it.

If one could vary the bandwidth of the receiver by a suitable variable-selectivity control, the effect on output noise of narrowing it would obviously be to reduce the noise, and at the same time alter its character. The alteration in character would not be conspicuous on a loudspeaker, but it was very prettily demonstrated by the receivers used at CH radar stations during the war, as the many R.A.F. and W.A.A.F. characters who operated them no doubt remember. The i.f. in these receivers was 2Mc/s, and there were three alternative bandwidths: "narrow" (50kc/s); "medium" (200kc/s); and "wide" (500kc/s). When the set was switched to "narrow," the noise that emerged from the i.f. amplifier was centred on 2Mc/s but included components 25kc/s above and below this. It could be regarded as a 2-Mc/s carrier wave modulated with complete irregularity at all frequencies up to 25kc/s. The detector converted the centre frequency to zero, and the noise voltages reaching the vertical deflector plates of the c.r. tube contained all frequencies up to 25kc/s. One half cycle of this highest frequency lasts for 20μsec. The time taken for a radar signal to go 1 mile and back again is 10.7μsec, so even the narrowest pulse of noise would occupy a width on the range scale equivalent to nearly 2 miles, or about one hundredth of the whole scale. Most of the noise structure, being lower in frequency, was still coarser, the general appearance being as in Fig. 2(a). (Because 25 pictures like this but all different in detail were superimposed per second, the noise actually looked more massed together than this, but all the outline

were decidedly rounded.) With the switch at "medium" the noise frequencies ranged up to 4 times as great, so it looked much spikier ; and on " wide " there were noise frequencies up to 10 times the maximum on " narrow," so spikes could be less than 0.2 mile wide, making a typical picture more like Fig. 2(b) and the visible effect like very fine grass in a lively state of animation. The amplitude was not changed very much by bandwidth switching, because what the amplifier gained in bandwidth it lost in amplification.

At long and medium-wave broadcasting frequencies there is generally so much noise of other kinds—atmospherics, electrical equipment noise, and radio interference—that electron noise is seldom heard above the tumult. A possible exception might be a highly sensitive set with a very small aerial—say a small frame aerial loosely coupled to the first tuned circuit. In such a case the incoming signal might be so feeble that the set gain would have to be brought up to the point where it would reveal Johnson noise of the input circuit. But generally speaking it is only at the higher frequencies that electron noise is a major problem. Radar is the outstanding example of noise-limited communication ; but v.h.f. radio is also affected.

We saw that in the microphone amplifier, likely values being assumed, the amplifier itself did not contribute a significant part of the noise. It all came from the signal source. That is the best possible situation ; the standard or ideal condition with which all others are compared. Assuming, as we did, that the input impedance of the amplifier was infinite, increasing the step-up transformer ratio would increase the signal voltage in the same proportion. But it would also increase the square root of the source resistance—and hence the noise voltage—in the same proportion. So, provided that the transformer ratio was high enough to make the source resistance much greater than the equivalent noise resistance of the first valve (so ensuring that the amplifier noise was negligible), there would be no point in raising the ratio further. The signal/noise ratio would not be appreciably affected. But if, for example, a 1-kΩ microphone were connected straight to an amplifier whose first valve had an R_{ee} of 2kΩ, the result would be to multiply the noise/signal ratio by 3, compared with the ideal noiseless amplifier. This condition is stated compactly by saying that the *noise factor* is 3. It means that the result of amplifier noise is to make the noise 3 times as bad as in the ideal case where the signal source is the sole noise generator. In an ideal amplifier or receiver the noise factor (which is usually denoted by N) would be 1.

There are various slightly different definitions of noise factor (in America, " noise figure "), but I am not proposing to go into these. Perhaps the simplest way to reckon it is as :

$$N = 1 + \frac{\text{noise power generated by receiver (referred to the input terminals)}}{\text{noise power at input terminals due to signal source.}}$$

Try checking the factors in the examples (1 and 3) by this.

When the first stage amplifies largely, it is the only one that need be considered as a noise generator. Otherwise, the second and perhaps even third stage will contribute appreciably. So clearly the first requirement for low noise factor is a reasonable gain

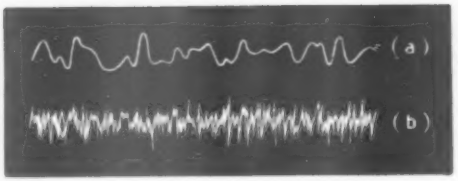


Fig. 2. Appearance of noise on a c.r. tube trace when the amplifier has a (a) narrow (b) wide bandwidth.

from the first stage—say at least $\times 3$ in voltage. While there is no difficulty about this up to perhaps 100Mc/s, it becomes rather a problem at higher frequencies.

The next thing is to see that the first valve introduces as little noise as possible. This is judged by comparing its R_{ee} with the source resistance, both being referred to the same point—the input terminals—as we have already been doing. Some readers may prefer to do the thing a little more mathematically. The noise voltage due to a resistance R is, as we know, $2\sqrt{kTBR}$. As we shall be having rather a lot of this $2\sqrt{kTB}$ thing, let us denote it by K for short, so that we can write the noise voltage as just $K\sqrt{R}$. Now look at Fig. 3(a), where the signal source is represented by the circuit to the left of the dotted line. R is its resistance, E_s the open-circuit signal voltage, and $K\sqrt{R}$ the open-circuit noise voltage. These are all the essentials. For the reasons I explained there is no need to show R_{ee} as a resistance ; the essential thing is its noise voltage, $K\sqrt{R_{ee}}$, which is equivalent (so far as the valve output is concerned) to the shot effect inside the valve. The signal/noise voltage ratio of what is coming from the signal source is clearly $E_s/K\sqrt{R}$, but to be able to add different lots together we must reckon in power*, and on that basis we have to square the voltages, making the signal/noise power ratio E_s^2/K^2R. The signal noise ratio of what comes out of the valve (and—since we are neglecting noise from later stages—out of the amplifier as a whole) is worsened by R_{ee}, being $E_s^2/K^2(R + R_{ee})$. The noise factor N, which is the worsening factor, must be the ratio of these two signal/noise ratios : $E_s^2/K^2R \div E_s^2/K^2(R + R_{ee})$, which simplifies to $(R + R_{ee})/R$, or $1 + R_{ee}/R$, in agreement with our general definition of N.

If a $1 : n$ step-up transformer is used, the corresponding representation is Fig. 3(b), where we see that the signal voltage is n times greater ; the source noise voltage is also n times greater ; so the source signal/noise ratio is unchanged. But N is changed from $1 + R_{ee}/R$ to $1 + R_{ee}/n^2R$. So if R_{ee} is substantial compared with R, the step-up considerably improves matters ; but if not, not. Try a few values and see. In our microphone amplifier there was no foreseeable reason why n^2R should not be made far greater than R_{ee}, so bringing N down nearly to the ideal 1.

But the radio receiver, being as we suppose highly sensitive, is almost certain to have at least one frequency changer. The mere process of shifting the incoming r.f. band to a different (usually lower) r.f. called the i.f. does not in itself necessarily increase

* " Total Power," March 1952.

noise. But if the designer were to say to himself that it was so much easier to amplify at i.f. than at a very high r.f. that he would do all his pre-detector amplifying at i.f., it would mean that the first stage was the frequency changer. For various reasons a frequency changer generates considerably more noise than a straight amplifying stage. There is the oscillator to make a contribution. Then a frequency-changer valve such as a hexode has a lot of electrodes to cause partition noise. But the most serious thing is that the conversion conductance is at best only about one-third of the mutual conductance. What this means is that for a given r.f. signal input the i.f. output voltage from a frequency changer is at most about one-third of the r.f. output of a similar valve used as a straight amplifier. But the noise generated is at least as much, so the net effect is a serious drop in signal/noise ratio, or rise in noise factor.

The answer is to use at least one stage of r.f. amplification before the frequency changer, provided it can be coaxed into amplifying usefully. But when one gets into thousands of Mc/s—and for most people considerably less than that!—all coaxing fails, and (except for the new travelling-wave tube) there is nothing for it but to use the quietest frequency changer that can be got. This problem was acute during the last war when microwave radar was introduced; the solution was the crystal diode, which was the ancient crystal detector brought up to date.

Return of the Triode

At the same time the frequency at which r.f. amplifiers could be made to work was pushed considerably up. It is perhaps rather puzzling to find that triodes are used. One was taught that a triode was useless for amplifying even moderately high frequencies because of feedback from anode to grid, causing oscillation. So it seems paradoxical to find them being used to extend the range of useful r.f. amplification into the hundreds of Mc/s. The reason they are preferred is that the fewness of electrodes causes them to be quieter than multi-electrode valves. And the reason they can be used is the earthed-grid technique. Instead of the usual type of connection, Fig. 4(a), the input leads are reversed (b). The earthed grid acts as a screen between the input (cathode) and output (anode). This scheme would not succeed at ordinary broadcasting frequencies, because the amplification is very poor by pentode standards, and the input impedance is very low. But at the frequencies in question it would be low anyway, and one is thankful for a gain of even 2 or 3, provided that valve noise is small.

If, with Fig. 3 still in mind, you are wondering why there is such a fuss about the first valve, seeing that we swamped its shot noise by using a sufficiently high step-up ratio n, the answer is that while Fig. 3 may be a fair enough representation of an a.f. amplifier, with its supposedly infinite input impedance, it certainly will not do at very high r.f., where the input resistance is quite low owing to electron transit-time and other effects. At 100Mc/s it is only a few thousand ohms at best, and may actually be less than R_{eq}. Moreover, it is necessary to have some sort of input tuning circuit, and its dynamic resistance comes in parallel with the valve input resistance. So the simplest equivalent circuit that can be used is Fig. 5, in which R_i is the input resistance of the valve and the input circuit lumped together; and of course it gives rise to its own noise voltage $K\sqrt{R_i}$. The signal voltage reaching the valve is no longer nE_s, but $nE_sR_i/(n^2R + R_i)$; and the maximum for a given E_s and R_i is obtained by making $n^2R = R_i$. This is done by adjusting the step-up ratio n. If R_i is lower than R, n would have to be less than 1, so it would be a step-down.

It is quite straightforward to apply the general

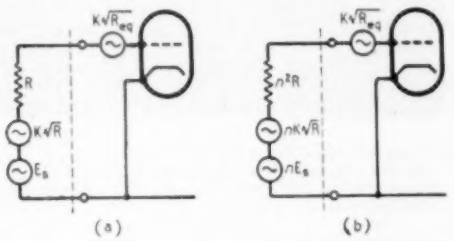


Fig. 3. In these equivalent circuits the signal source is represented by the generators (signal and noise) to the left of the dotted line, and the shot noise in the valve by the generator $K\sqrt{R_{eq}}$ (R_{eq} being the "equivalent noise resistance" of the valve). (b) is the same as (a) except that a 1 : n transformer is used between source and amplifier.

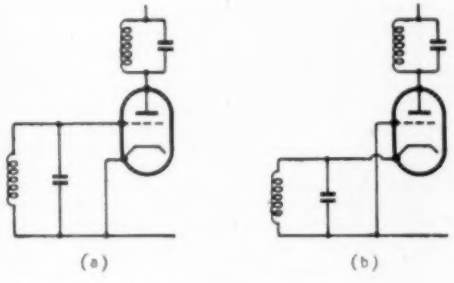


Fig. 4. At very high frequencies the input resistance of a valve is quite low, and it is advantageous to change from the conventional connections (a) to the earthed-grid scheme (b). (In practice the tuning circuits are altered too, but here they are drawn the same as in (a) in order to emphasize the difference in valve connection.)

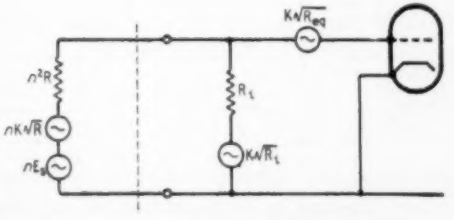


Fig. 5. Elaboration of Fig. 3(b) to include the effect of input circuit resistance (both inside and outside the valve), represented by R_i, with its own noise generator $K\sqrt{R_i}$.

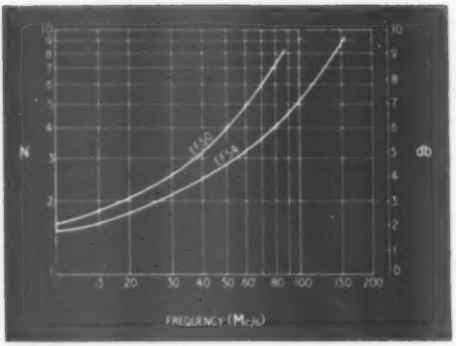


Fig. 6. Examples of how the lowest possible noise factor (N) rises with frequency, showing the result of improvements in the design of the EF50, embodied in the EF54. All depends on the first valve in the set.

formula for noise factor to this equivalent circuit, and the result is

$$N = 1 + \frac{n^2R}{R_i} + R_{eq}\frac{(n^2R + R_i)^2}{n^2RR_i^2}$$

Although this formula may look rather formidable, it shows up the situation quite clearly. First, suppose the valve itself is noiseless: $R_{eq} = 0$, so the last term goes out and leaves $1 + n^2R/R_i$. If the input resistance of the valve is infinite (as we assumed with the microphone amplifier), the second term goes out too and we are left with $N = 1$, meaning a perfectly noiseless amplifier. Next, still with $R_{eq} = 0$, adjust n to make $n^2R = R_i$ to get maximum signal into the amplifier. Now $N = 2$. Reducing n, making the input coupling a step-down ratio if necessary, mismatches the load and reduces the signal strength, but also reduces N, so improves the signal/noise ratio. With a truly noiseless valve, we could in this way get as near the ideal $N = 1$ as one wished; but in practice R_{eq} puts a limit to it, for if n^2R is made very much smaller than R_i the last term reduces to approximately $R_{eq}n^2R$; which shows that the more n is reduced the greater this term becomes, and the worse the noise factor.

So we find that if the step-up ratio n is made very large the second term becomes large; if it is made very small the third term becomes large; in either case the noise factor rises. For every given R_i and R_{eq} there is a best n that gives lowest N. So we see (1) that the coupling of the aerial or other signal source to the receiver is important; (2) that matching the aerial impedance to the receiver, though it may give the strongest signal, does not give the lowest noise factor; and (3) that when the input resistance R_i falls (as it does rapidly at frequencies above 30Mc/s) it spoils one's chances of reducing the effect of valve noise (R_{eq}) by increasing n. So, as the frequency rises, N is bound to rise too; and that is why the electron noise problem is so serious in v.h.f. and radar. Fig. 6 shows two examples of how the best obtainable noise factor rises with frequency. The higher the frequency, the more important it is to choose a first valve (or crystal) with as low a noise resistance as possible. At the same time, as we have noted, its gain should be high enough to make the noise contribution of later stages negligible in comparison.

In practice one can't calculate N accurately, and it is necessary to measure it. The simplest method is to use as one's signal generator a "noise diode"—a diode valve used under the conditions that do allow of reasonably accurate calculation from the formula repeated at the beginning of this article. L. A. Moxon has covered this subject in the Jan., 1947, issue; and some of the radio instrument makers produce suitable apparatus.

A final point—the fact that a set has a satisfactory noise factor doesn't guarantee a good signal/noise ratio. The definition of N shows that it could be brought as near the ideal 1 as one liked by loading the signal source up with resistance. But since that would degrade the signal/noise ratio more than it improved N the last state would be worse than the first. So R_i as well as N, should be reduced to a minimum.

TELEVISION EYESTRAIN

Results of Enquiry by Opticians

TO what extent is television affecting the nation's eyesight? In an endeavour to answer this question the Association of Optical Practitioners submitted a questionnaire to a representative sample of opticians in the service areas of Alexandra Palace, Sutton Coldfield and Holme Moss. The results of this investigation, which is the first of its kind to be undertaken in this country, were embodied in a report submitted to an optical congress at Bournemouth in April.

It would appear, from an analysis of the replies to the questionnaire, that up to one half of the country's viewers may associate symptoms of eyestrain with the use of television. The lecturer, J. L. H. Moss, stressed, however, that a person who is not an avid reader or cinema enthusiast may have a minor visual defect which does not inconvenience him in his normal occupation. Then, having acquired a television set, he spends hours concentrating on a small screen. His eyes become tired and he finds he needs spectacles, as he probably would have done had he suddenly developed a keen interest in books or films. Television did not cause the trouble, it drew attention to a small existing visual error which needed correction.

Television has introduced new visual problems and, "in the interests of comfort in viewing," the Association of Optical Practitioners has issued a pamphlet drawing attention to seven simple rules to ensure viewing without eyestrain. These include the injunction to view in a reasonably illuminated room (it is inadvisable to look at television in a darkened room). The ideal viewing position is directly in front of the screen at a distance of approximately eight times the diameter of the tube and looking slightly down.

Two of the seven rules draw attention to the need for correct adjustment of the set. Incidentally it would appear from an analysis of the replies to the questionnaire that probably 65 per cent of viewers are operating their sets under conditions which could be improved if more attention were paid to lighting, viewing distance and the correct adjustment of the brightness control.

It is interesting to note that the findings of this investigation confirm the results of similar research undertaken in America.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

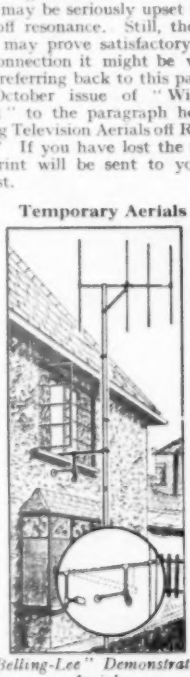
Does the presence of trees affect T.V. Reception?

This was one of the questions asked at one of the recent series of conferences held by us in the area to be served by the Wenvoe transmitter. Our lecturer told his audience that at his home, there is a bank of trees between his aerial and some cooling towers. In the winter, when there are no leaves on the trees, he is troubled by a bad "ghost" but in the summer the "ghost" goes. Presumably the same answer could be given to the question "Are 'ghosts' seasonal?"

Will I have to change my Channel (a) Aerial when I change to a Channel (b) Receiver?

It is extraordinary how often this question crops up. Obviously it is quite easy to connect the new receiver to the old aerial and see what happens. It is only fair to arrange for the aerial to be orientated to the best position (a) for signal (b) against interference or "ghost"; don't forget that the polar diagram of a multi-element aerial may be seriously upset when used off resonance. Still, the old aerial may prove satisfactory. In this connection it might be worth while referring back to this page in the October issue of "Wireless World" to the paragraph headed "Using Television Aerials off Resonance." If you have lost the issue, a reprint will be sent to you on request.

Temporary Aerials



"Belling-Lee" Demonstration Aerial.

We are often asked how best to arrange a demonstration without the necessity of raising ladders and lashing an aerial to the chimney. A year or more ago we marketed a special bracket designed to hold an aerial on a pole, from an upstairs window of a two storey house. This bracket arrangement is illustrated here, and we suggest many readers may find it a useful piece of equipment.

Interference with Television Reception. Post Office Instruction

The Post Office engineering department have published a very useful instruction, known as Radio Interference B.0007. It shows pictures of twenty-six T.V. tube faces each depicting some form of interference or distortion, and gives the probable cause. If readers cannot obtain these elsewhere, we have a very limited number which will be distributed while the quantity lasts.

Ratio of Local Interference to Distant Signal

When a distant signal is being received spoilt by local interference, it is often well worth while to try changing the position of the aerial. For example, take a usual house by the side of the usual road, the kind of place most of us live in. The aerial is probably on the chimney, within thirty feet of the centre of the road and say thirty miles from the transmitter. If car interference is severe, try moving the aerial to a pole at the bottom of the garden. In this way you may double the distance from the interfering source to the aerial, and at least halve the interference, but though the programme signal remains the same, you improve the signal-to-noise ratio. Obviously the same technique applies if the local interference comes from a selfish neighbour. The chimney may be the most convenient place to put the aerial, but don't become too narrow minded about it, there are other places.

Mechanical Construction

An aerial may be perfectly dimensioned to produce an optimum signal and yet be a bad aerial. It must be remembered at all times, that an aerial has to stand up to conditions, probably worse than those of any other piece of domestic equipment. The exposed position means buffeting by all the winds that blow, at times up to 100 m.p.h. Subjected to salt spray in coastal areas and nearly always to sulphurous fumes from chimneys. Aerials must be so constructed to withstand the mechanical stresses and chemical corrosion. The best way to combat corrosion is to protect exposed metal parts with paint at intervals of about a year. Don't paint the insulator.

Folded Dipoles

We have designed and manufactured these for export, and in addition folded dipoles of our design are manufactured under our licence in several continental countries. For example we have designed a director dipole and reflector array for the Lille transmission operating on 186 megacycles and horizontally polarised. This array would be suitable for reception of English Schools television, being radiated on 200 megacycles. If this interests any readers please write direct to Enfield. We have no axe to grind regarding folding the dipole; this has its uses, for example as a means of matching, but is extravagant in material and results in increased windage. In our opinion the reception of British television on the normal frequency channels is not one of their more useful applications.

Indoor Aerials

The "Doorod," the first domestic dipole with one rigid and one flexible element, is generally illustrated with the whole or part of the flexible element bent at right angles. This is to illustrate the feature, which resulted from the fact that channel one calls for a dipole eleven feet long, and we don't all live in rooms as high as that. We do want to emphasise that as a collector, the "Doorod" must normally give best results when fully extended. If bent at right angles, the pick-up is almost half. There are many situations in a strong signal area, where advantage may be taken of the flexibility and versatility of the "Doorod" such as giving it a useful polar diagram by using it as an inverted "V."

Will those in coastal towns, fishing ports, yachting centres etc., bear in mind that "Belling-Lee" are specialising in suppression on board ship.
We have done much work on ships of all sizes from the "Queen" class to trawlers, drifters and yachts.

Written 25th April, 1952.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD. ENFIELD MIDDX. ENGLAND

Two Marconi RB.109 Automatic Marine Beacons are being erected in South Georgia, primarily for the use of Antarctic whaling fleets. The stations are designed to operate without attention for three months at temperatures down to 12°F and wind velocities up to 120 m.p.h.

Fully duplicated beacons, Type WB.8, are being installed on Troughton Island, off Western Australia, to aid shipping in the vicinity of the dangerous Penguin shoals. The station will provide high power MF beacon transmission by automatic time control and on "request".

MARCONI marine beacons

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD · CHELMSFORD · ESSEX

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Colour Coding

I STRONGLY disagree with "Diallist" when he writes desiring resistors to be marked with figures instead of colour coded (p. 206, May *Wireless World*). Colour coding enables a resistor to be quickly located and its value easily read even if it is more than half buried by wires and other components in a set. Again, colour coding makes it easy to spot the required value among a whole box full of resistors. I do, however, think the "spot" colour should always be a band, first, because there is much less chance of it being rubbed off, and secondly, because it cannot be hidden by being under the resistor as can happen with a spot. For the same reason, if figures *must* be used, they should be repeated in a spiral right round the resistor.

Regarding the wattage rating, this can usually be seen by the size of the component, but if it is thought necessary, it is *this* that could be marked on in figures, since one need only know the wattage when selecting the resistor for the job.

Surely any experimenter worthy of the name should find little difficulty in mastering the standard colour code when it is to his advantage to do so.

Totland Bay, I.o.W. R. V. GOODE.

I MUST differ from "Diallist" on colour coding (your May issue).

Whilst admitting that a number on a piece of paper is quicker to read than a set of colours, these conditions do not obtain in radio work. Having worked on a number of continental receivers where colour coding is seldom used, I know the time wasted in pushing components about to read the value of a "submerged" resistor and if you keep your resistors in trays or boxes in decade steps you will know how quick it is to find a particular value by colour, but how hard it used to be in pre-coding days.

Then, too, when servicing a set where a circuit diagram is available, the particular section one is interested in can be found immediately by the distinctive colouring of the resistors associated with that circuit—far quicker than were there sets of numerals.

No, Sir; while admitting the many small disadvantages of the present coding, I cannot agree that reverting to figure marking would be helpful—or even sane, with the increasing complexity of equipment.

Beckenham, Kent. P. G. SKANE.

Hot Stylus Technique

IN reply to D. W. Aldous's letter (April issue), I should like to make the following points.

My main reason for winding the coil immediately above the sapphire on the shank, in preference to the shank itself, is simplicity. It is far easier to wind a dozen or so turns of 44 s.w.g. wire on the shank than it is on the small length of sapphire that is usually available between the shank and the tip. Further, due to the inherent tendency of the swarf to ride up the flat of the cutter, which is even more in evidence when the cutter is heated, there is far greater danger of the swarf coming into contact with the coil and volatilizing.

These advantages, I consider, outweigh the disadvantages that more heat must be applied to overcome that lost by conduction away from the tip by the shank, and that the moving parts of the cutter head must be capable of dissipating the slight increase of heat without affecting any thermosensitive compliance.

D. W. Aldous states that "currents of the order of 0.4 to 0.5 A may be employed," but gives no indication of the resistance of the coil he uses, which might vary from 0.5 to 35 Ω, depending on whether he uses copper or resistance wire. What is of importance is the watts dissipated in the coil, and about 0.75 watt appears to be the optimum; any appreciable increase on this figure is merely dangerous, due to the liability of the swarf to ignite. A plot of surface noise against power input to a coil taken on a 33⅓-r.p.m. disc at 5in diameter, with a 10-micron bevel, shows a rapid fall of surface noise as the power is increased up to 0.5 watt, and then a flattening out as the curve becomes asymptotic to a figure determined by rumble and other mechanical noises. An improvement of some 20 db can result.

In order to effect an improvemnent on the upper frequency response the bevel may be reduced to about 5 microns with hot stylus without depreciation of surface noise.

M. C. PHILIP.

Northwood, Middlesex.

I SHOULD like to add a little more information, gathered from experiments made by my company, on the subject of hot stylus technique.

As we all know, the highest possible quality obtainable on disc is achieved by using a sharp edge stylus on wax. For obvious reasons this is not practicable except where a reasonable number of copies are required to warrant the cost of processing, hence the acetate disc.

Acetate offers considerably more resistance to the stylus, and even when using a cutter head with plenty of "punch," the groove when cut with a sharp stylus is noisy and grey in appearance. The best method we have found to overcome this is to dull the cutting edge in such a way as to produce a minute radius (0.00015in) along the entire working edges of the sapphire, which would normally be sharp. A stylus of this type, when set into the cutter head with care, produces a bright and silent cut with a very good top frequency response, but the average commercial recording studio simply cannot spare the time usually required to fiddle about adjusting the angle of cut; added to which is the cost of expensive discs used up during this process of getting the cut right.

The negative bevel (Capps') American patent, which is used almost universally to-day, produces a clean, bright cut with a minimum of adjustment, but with a reduced top response.

The hot stylus which is intended to combat this condition, that is to produce a clean, quiet cut with a good top response, does do this, but it also introduces a noticeable element of distortion. By cutting at very slow speed with a microscope rigged up immediately behind the cutter head it is possible to observe the freshly cut groove which has been

warmed by the sapphire at the moment of contact slowly creeping back to an altered position on cooling; in other words, the groove actually changes its shape after having been cut. However, in spite of this defect, hot stylus is at present the most practical method of direct disc recording, in so far as it does achieve the best possible results with a minimum of trouble to the recording machine operator.

Concerning the origins of this method of recording, I believe that a resistance-heated stylus was tried out in this country by L. Stroud as far back as 1930.

E. R. WALLWORK.

Colton & Co. (Lapidaries), Ltd.,
London, S.W.19.

HEATING the stylus is only one way of warming the recording medium, and sounds rather crude to me unless radius compensation is applied to ensure uniformity of heat transfer at all linear groove speeds.

I have vivid recollections, as a small boy (*circa* 1912), of helping my father to make direct-*cylinder* recordings with an Edison-Bell phonograph. As No. 2 on the machine, my job was to hold a hot flat iron an inch or two from the surface of the wax; my reward was a sound cuff when I allowed the iron to lag instead of lead the soundbox.

HENRY MORGAN.

Hindhead, Surrey.

Picture Quality

WITH reference to the suggestion of C.E.S.R. in your May issue, concerning a type of "frame displacement" at 12.5 times per second, I would like to mention of my own experience of this device. In 1946-47 I and some colleagues were experimenting with "cross scanning sequences"; that is, one frame vertical, next frame horizontal, with the lines in the opposite sense. During this period we actually put into practice the scheme suggested by C.E.S.R. and the result was this. Although one can synthesize triple interlace with this device, the additional low frequency (12.5 c/s) component gives rise to excessive eye strain, and this can be minimized by ensuring that only pure square wave forms are used to shift the frame mean position. But even here the presence of such a low frequency component cannot be eliminated, and can only extend the very short viewing period without eye strain. With reference to the extra brightness available suggested by C.E.S.R., it is surely not the same as in spot wobble; for one thing, the mean length traced out by the spot is not increased as in spot wobble where the spot traverses a larger area for a given "line." HENRI THOMAS PICHAL.

Westcliff-on-Sea, Essex.

"*Standardizing Television I.F.*"

THE letter from the Secretary of B.R.E.M.A. in your April issue is very good in its own way. The choice of the i.f. will do something towards freeing television from interference by other services, but it is to be hoped that this alone is not the best to be expected, as it is not sufficient.

Any amateur with a 150-watt transmitter on 14 Mc/s knows only too well that, even when he has eradicated harmonics, sets in his vicinity will be swamped by his fundamental signal, which is about *sixty per cent* off tune at the receiver. To talk, as some dealers do, of amateur "interference" under these conditions, is almost impertinence. "Receiver incompetence" would be a better term.

The amateur, to remain on friendly terms with his neighbours, usually provides a high-pass filter. The mere fact that it so often succeeds proves that the trouble is not usually due to illegal radiation on his part. One wonders what happens when commercial and Services transmitters cause interference. Do *they* have to accept responsibility for wide-open r.f. or mixer stages in television receivers?

The onus should be on the receiver designer to clear the trouble by the inclusion of a cheap and simple high-pass filter, cutting off at about 35 Mc/s. For the "high i.f." adherents this would be an i.f. rejector. For the "low i.f." supporters it would be the cure for second-channel interference. For the transmitting amateur it would be merely justice.

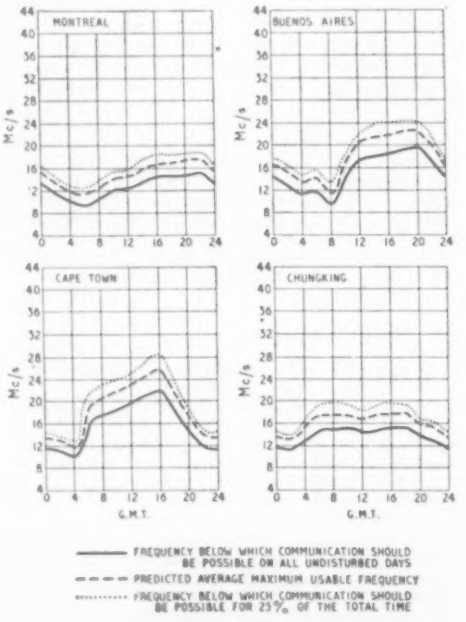
Worksop, Notts. H. S. CHADWICK, G8ON.

Short-wave Conditions

Predictions for June

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during June.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.


MONTREAL
BUENOS AIRES
CAPE TOWN
CHUNGKING
Mc/s
G.M.T.
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

WORLD OF WIRELESS

Allocating Europe's Television Frequencies • A.M./F.M.: Present Position • Marine Navigational Beacons

European V.H.F.

THE conference of representatives of all countries in the European Broadcasting Area to discuss the question of v.h.f. broadcasting in Europe meets in Stockholm on 28th May. The main matter on the agenda is the allocation of frequencies for television and sound broadcasting in the bands 41-68, 87.5-100 and 174-216 Mc/s.

Although these bands were allocated at the Atlantic City Conference (1947) to European broadcasting, there were provisos permitting the use of sections of them for other services. We in this country, for instance, may use 66.5-68 and 95-100 Mc/s for mobile services, 85-90 for maritime radio-navigation, 94.5-95 for meteorological aids; 174-200 for fixed service; and 200-216 for aeronautical radio-navigation.

The British delegation to the conference which is scheduled to last a month numbers about ten—mainly B.B.C. and G.P.O. representatives.

Marine A.M. or F.M.?

IT will be recalled that the question was raised in the House last July regarding the request from the United States for the U.K. to reconsider its decision to use a.m. for single-channel v.h.f. maritime radio services. Incidentally, a.m. has also been adopted by a number of European and Commonwealth countries. The former P.M.G. (Mr. Ness Edwards) stated in July that he would stand by this country's decision in any international discussion.

Efforts have been made in various quarters to find a solution to this problem and *Wireless World* understands the Post Office hopes to have further discussions with other countries fairly soon and that it will continue to advocate the use of a.m.

During a recent visit to the United States, John Brinkley of Pye's, had an opportunity of discussing the a.m.-f.m. question with officials of the F.C.C. and the Port of New York Authority, when Pye a.m. equipment was successfully demonstrated. Apparently America has not committed herself so deeply as this country, and there are as yet very few v.h.f. radio-telephony harbour installations.

Show News

WHEN the ten-day Manchester radio show closed on May 3rd, a total of 100,793 people had seen the exhibits of the 39 manufacturers and eight other exhibitors. Twenty-eight of the manufacturers demonstrated television receivers in the communal viewing avenue, and in all there were about 160 television sets being demonstrated in the exhibition.

A proposal had been made to hold a show in Glasgow later this year, but the R.I. Council has decided against this in view of the Government's decision to reduce production for the home market.

At the recent ballot for stands at the National Radio Show (Earls Court, August 26th—September 6th) space was allocated to about 90 exhibitors.

It has been decided to hold next year's components exhibition at Grosvenor House, London, W.1, from April 14th-16th.

Welsh Television Opening

WENVOE, the last of the high-power television transmitters to be built, is expected to be ready for operation, using the standby equipment (5-kW vision and 2-kW sound), on 15th August. The official opening, by the Postmaster-General, Earl De La Warr, will be preceded by test transmissions.

The 50-kW main vision transmitter for the Wenvoe station is being manufactured by E.M.I. and the 12-kW sound transmitter by Standard Telephones and Cables. The station will operate in channel five (63.25 Mc/s sound, 66.75 Mc/s vision).

Radio Beacons

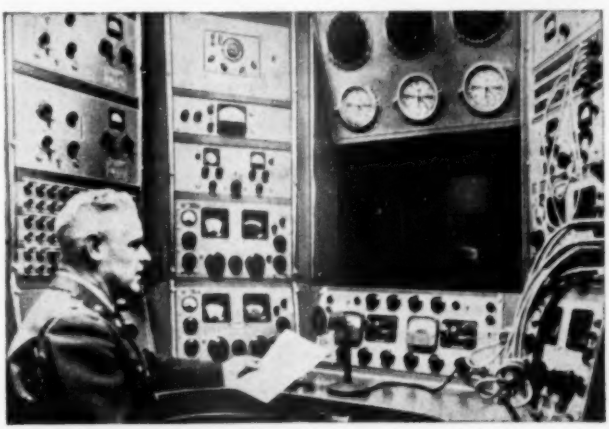
NEW equipment to comply with regulations laid down at the conference for the reorganization of maritime radio beacons (Paris, April, 1951) is to be supplied by Marconi's for over forty lighthouses and light vessels round the coasts of Great Britain. The new 20-watt medium-frequency navigational beacons, ordered by Trinity House, provide fully automatic operation with duplicate equipment to avoid a stoppage in the service.

Under the new plan, which comes into operation in August, 1953, the beacons are arranged in groups of two, three and six stations. The transmissions from the stations in the groups will take place alternately over a 6-minute cycle so that a vessel will be able to "fix" its position very rapidly and accurately by the intersection of a number of cross bearings.

Engineer's Jubilee

THE distinction of being the first engineer to spend fifty years in the wireless industry is claimed by Raymond D. Bangay, who, having joined the Marconi Company on 15th May, 1902, is still in the company's employ. In 1902 he went to America and for five years helped with the erection of stations, including the first U.S. coastal station.

In 1921 he was appointed chief of designs and in 1925 technical repre-



PRESIDENTIAL COMMUNICATIONS. — The array of controls at the console of the radio installation on the U.S. Presidential train gives some idea of the diversity of facilities available. They include radio-telephony, facsimile and teleprinting.

sentative abroad. He has held his present post—Foreign Manager—since 1935.

Wireless World is particularly interested in this jubilee for R. D. Bangay was the author of the first wireless text book, "The Elementary Principles of Wireless Telegraphy"—published by *W.W.*

PERSONALITIES

H.R.H. The Duke of Edinburgh has accepted the invitation of the Radio Industry Council to be the Guest of Honour at its second annual dinner at the Savoy Hotel on November 25th.

Lord Burghley, K.C.M.G., who is chairman of Cossor's, has accepted the invitation of the Radio Industry Council to become its president. He succeeds Mr. Oliver Lyttelton, who relinquished the presidency, which he had held since 1947, on taking office as Secretary of State for the Colonies.

Sir Robert Watson-Watt, C.B., F.R.S., who recently opened a Montreal branch of his company, Sir Robert Watson-Watt & Partners, has been appointed adviser on radar and electronics to the Canadian Defence Research Board. As the new post is a part-time one, Sir Robert will retain his advisory posts in this country.

Frank C. Connelly, Ph.D., A.M.I.E.E., has relinquished his post as head of Murphy's Electrical Design Dept. to become managing director of Acoustic Products, Ltd., a subsidiary of Murphy Radio. During most of his eighteen

DR. F. C. CONNELLY

years at Welwyn Garden City he has been associated with the electrical design of equipment. In 1950 Dr. Connelly produced a comprehensive work, "Transformers—Their Principles and Design for Light Electrical Engineers." He has done considerable work on safety precautions in receivers, and contributed an article on this subject in our January, 1951, issue.

Dr. Lee de Forest, pioneer of the three-electrode valve, was recently honoured by the American radio industry on the 50th anniversary of his entry into wireless.

D. P. Taylor, M.B.E., A.M.I.E.E., who had been with the Ministry of Civil Aviation since 1946, has relinquished the post of Senior Signals Officer in charge of telecommunications training to join the International Civil Aviation Organization. For three months he will be at the I.C.A.O. headquarters in Montreal and will then go on a two-year "technical assistance mission" to another country as civil aviation telecommunications adviser. Mr. Taylor was a Marine radio officer prior to joining the B.B.C. in 1935 as a maintenance engineer on high-power transmitters. During the war he was Technical Signals Officer, R.A.F. After his term of duty with I.C.A.O. he will return to M.C.A.

OUR AUTHORS

R. Brewer, who contributes the article "Valve Life Testing" in this issue, joined the Research Laboratories of the General Electric Co. in 1937 as a member of the Illuminating Engineering Dept. After considerable wartime experience with the production of experimental valves for radar and similar purposes, he was put in charge of the Valve Life-Testing Dept. in 1943.

G. N. Patchett, author of the article on interlacing on page 219, became Head of the Electrical Engineering Dept. of Bradford Technical College in May, where he has held various academic posts since 1940 when he joined the staff of the college to teach Servicemen radio. His own academic training was received at the college, where he graduated B.Sc. (electrical engineering). In 1946 he received the Ph.D of London University. He is an associate member of both the I.E.E. and the Brit. I.R.E.

F. R. W. Strafford, author of the article "Television Receiving Aerials," the first part of which appears in this issue, entered the radio industry in 1922 and commenced research work with Kolster-Brandes in 1928. He has undertaken research and development work with various companies and is now technical manager of Belling & Lee, Ltd. Mr. Strafford gained corporate membership of the I.E.E. by a thesis on the super-regenerative detector and has written and lectured extensively, particularly on aerials and radio-interference problems.

B.B.C. APPOINTMENTS

F. Axon, who joined the B.B.C. in 1941 as a member of the Overseas and Ionosphere Section of the Overseas and Engineering Information Department, becoming head of the section in 1949 and head of the department in 1951, has been appointed senior supt. engineer, external services. He has represented the B.B.C. at several international conferences, including Rapallo, Geneva and Mexico City.

F. Williams, B.Sc.(Hons.), M.I.E.E., who becomes senior supt. engineer, home broadcasting, has been with the Corporation since 1925. He has been engineer-in-charge at several stations and from 1943 to 1949 was asst. supt. engineer, studios. He has been supt. engineer, studios, since 1950.

H. G. Whiting, A.M.I.E.E., has relinquished his post as engineer-in-charge of the Sutton Coldfield transmitting station, which he has held since 1949, to become assist. E.-in-C. (Television), Birmingham. He joined the B.B.C. in 1932 at the Daventry station as a maintenance engineer, and four years later transferred to the London television station as vision equipment engineer and senior maintenance engineer, development. He returned to Alexandra Palace in 1946 as senior maintenance engineer, studios, having served as senior maintenance engineer at the Rampisham short-wave station during the war.

R. D. BANGAY
(See "Engineer's Jubilee")

R. C. Harman, A.M.I.E.E., who succeeds Mr. Whiting at Sutton Coldfield, joined the Corporation in 1935. He has been on the maintenance staff at Daventry and Alexandra Palace and has been asst. E.-in-C. at Sutton Coldfield since 1949.

H. W. Baker, A.M.I.E.E., who is appointed supt. engineer, television studios, joined the staff at Alexandra Palace in 1936 after ten years' service at various transmitting stations. During the war he was E.-in-C. at Lisnagarvey and Ottringham and returned to Alexandra Palace in 1945.

T. H. Bridgewater, M.I.E.E., who has been E.-in-C. television O.Bs since 1946, becomes supt. engineer, television outside broadcasts. With the exception of the war years, when he served as a signals officer in the R.A.F., he has been associated with television. He joined the Corporation in 1932 on the introduction of the 30-line service.

H. Walker, O.B.E., A.M.I.E.E., is appointed head of technical operations in the television service. Since 1950 he has been E.-in-C. of the London television station, to which he was transferred from the Newcastle broadcasting station in 1936.

M. H. Hall, who has been with the B.B.C. for 25 years, becomes E.-in-C. television studios. He has been maintenance engineer at both broadcasting and television stations and since 1950 E.-in-C. at the Lime Grove studios.

W. D. Richardson, who succeeds Mr. Bridgewater as E.-in-C. television O.Bs, went to Brookmans Park as asst. maintenance engineer in 1930. With the exception of the war years, when he was in the Station Design and Installation Dept., he has been in television. Since 1947 he has been asst. E.-in-C. television O.B.s.

IN BRIEF

Sir Edward Appleton, speaking of the British development of television at the Silver Jubilee Dinner of the Television Society: "Even the full possibilities of the present system have not yet been fully exploited, especially on the camera side. Let us concentrate on getting the best out of what we have. It seems that we were wiser than we knew in

starting the 405-line system, for it turns out to be about the best compromise of fidelity, simplicity, and economy which could have been devised for home viewing. Anything more complex as regards the number of picture lines would have exposed us to the law of diminishing returns."

Receiving Licences.—The number of television licences in the U.K. increased by about 71,000 during March, bringing the total at the end of the month to 1,457,000. The increase during the first three months of the year was nearly 276,000. There were approximately 12,665,000 receiving licences (both sound and vision) current in Great Britain and Northern Ireland at the end of March.

Marconi's Birthday, April 25th, was the date ultimately chosen for the erection by the London County Council of the commemorative plaque on 71, Hereford Road, Paddington, recording that "Guglielmo Marconi (1874-1937), the pioneer of wireless communication, lived here in 1896-1897."

Baird's Birthplace, in Helensburgh, Dumbartonshire, now has a bronze plaque affixed to the wall recording that he was born there on August 30th, 1888.

Uruguayan Television Study.—The technical director of the Uruguayan broadcasting service, Senor Dante Tartaglia, has spent two months in this country (under the British Council's bursary scheme) studying British television. During his stay he spent a month with the B.B.C. and subsequently visited the factories and research establishments of a number of manufacturers. Senor Tartaglia is Professor at the Technical University of Uruguay.

Help Needed.—The Liberian Government is seeking the help of short-wave listeners in this country to assist in a survey of the coverage of the broadcasting station ELBC at Monrovia, which transmits on 6.025Mc/s daily from 15.15 to 23.15 G.M.T. Further details are available from the Liberian Government Public Relations Officer (6) at 20, Hereford Road, London, W.5.

"Physics and Sound Reproduction" is the title of the paper to be given by our contributor, D. T. N. Williamson, of Ferranti, Edinburgh, during the fourth conference on industrial physics (arranged by the Institute of Physics) to be held in the Royal Technical College, Glasgow, from June 24th to 28th. Details of the conference and the associated exhibition are available from the Institute of Physics, 47, Belgrave Square, London, W.1. The closing date for registration was May 15th, but applications from *W.W.* readers will be considered whilst there is room. Mr. Williamson's address will be given at 7.15 on June 25th.

Radio Officers' Union.—H. Moore has been elected chairman of the Radio Officers' Union for the second year. He has been on the marine staff of Marconi's since 1920. The new vice-chairman of the Union is G. W. Cussans, who is a Deputy Flight Radio Officer with the British Overseas Airways Corporation. Prior to 1936 he was a sea-going radio officer with Marconi's.

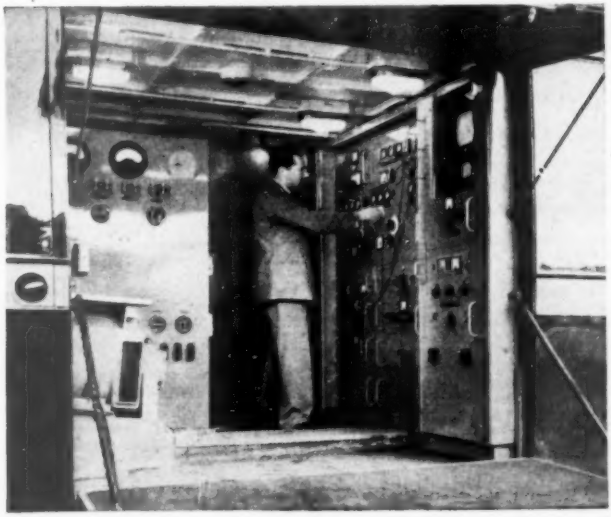
Radar Association.—At the recent annual general meeting of the Association, Air Vice-Marshall D. C. T. Bennett was elected president. Grp. Capt. W. Proctor Wilson, Head of the B.B.C. Research Dept., has become a vice-president.

Wireless Dinner Club.—At the 29th annual general meeting and dinner of the British Wireless Dinner Club (founded by wireless officers of the 1914-18 war), at which Sir John Cockcroft, C.B., F.R.S., was the principal guest, Admiral A. J. L. Murray, C.B., was elected president in succession to G. M. Wright, C.B.E. The new vice-president is Air Vice-Marshal C. W. Nutting, C.B.E.

Models Show.—Originally planned for August, "The Model Engineer" exhibition will be held at the New Horticultural Hall, Westminster, from October 20th to 29th. The radio-control of models will again be a feature of this exhibition, which is to be opened by H.R.H. the Duke of Edinburgh.

Electronic Films.—The first film to be taken using the electronic system, developed by High-Definition Films, Ltd., in co-operation with Pye and cinema interests, was shown during the I.E.E. convention at which a paper on the system was presented by Norman Collins (chairman and managing director of the company) and T. C. Macnamara (technical director).

SCHOOL TELEVISION. The pilot scheme for school television was opened for four weeks on 5th May. Using an O.B. transmitter similar to this one, the programme is radiated with a peak white power of 340 watts in the 184-200 Mc/s band on a 40° beam to six schools in N. London. Frequency converters, provided by the B.B.C., reduce the frequency to that of Kirk o' Shotts enabling standard receivers (lent by manufacturers) to be used. Sound is conveyed by G.P.O. line.



Brit. I.R.E. in India.—As a result of the recently concluded visit of the general secretary of the British Institution of Radio Engineers (G. D. Clifford) to India, Sections of the Institution have been established in Delhi, Calcutta, Madras and Bangalore—a Section was already in existence in Bombay.

Mechanical Handling in various forms is employed in radio factories and we therefore bring to the attention of production engineers in the industry the forthcoming exhibition at Olympia from June 4th to 14th. During the exhibition, organized by *Mechanical Handling*, a convention will be held at which one of the papers covers the subject of electronics in materials handling. Tickets for admission to the exhibition are obtainable from the organizers, *Mechanical Handling*, Dorset House,

Stamford Street, London, S.E.1. Separate tickets are required for the convention; these are obtainable on the day at the exhibition.

Amateur Show.—The R.S.G.B. has booked space at the Royal Hotel, London, W.C.1, for the week ending November 29th for its annual amateur radio exhibition.

A.R.R.L. Handbook.—The R.S.G.B. asks us to point out that it now has a stock of the 1952 edition of the A.R.R.L. Handbook so that copies can be supplied by return of post, price 31s post free.

Policing the Ether.—Plans have been approved by the European Broadcasting Union for the construction of a new Checking Station at Jurbise, near Mons, Belgium, in place of the present centre in the suburbs of Brussels. The change has been necessitated by the development of the previously rural district.

E.M.I. Scholarships.—The next four-year course in electronic engineering under the E.M.I. scholarship scheme, inaugurated in 1950, will begin at E.M.I. Institutes, 10, Pembridge Square, London, W.2, on October 14th. Applications for inclusion in the scheme, which provides for two six-month periods in the laboratories and workshops of the E.M.I. Engineering Development Co. during the course, must be made by August 29th. A descriptive brochure is obtainable from the Principal.

Digital Computing.—A Summer School in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory, Cambridge, from September 16th to 26th. The course will give a basic training in the mathematical use of machines, dealing with the processes employed and their embodiment in programmes which specify the operation in detail. A syllabus may be obtained from G. F. Hickson, M.A., secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

Electronics Course.—The fourth eight-week full-time course in electronics and electrical engineering for students with little or no knowledge of electronics, opens at the South-East London Technical College, Lewisham Way, S.E.4, on October 6th. Particulars of the course, for which the fee for students residing in the L.C.C. area is £6 13s 4d, are obtainable from C. W. Robson, Head of the Electrical Engineering Dept. at the College.

Plastics Progress.—A collection of papers, based on the lectures and discussions at the 1951 British Plastics Convention, has been issued under the title "Plastics Progress" by our contemporary *British Plastics* which sponsored the exhibition and convention. Recent developments in the technology of plastics and their applications to various industries are dealt with in this fifty-shilling book.

Testing Varnishes.—A proposal to test impregnating varnishes by means of a standard test coil has been investigated by the Electrical Research Association and is endorsed as a more realistic method of simulating practical conditions than tests on isolated films. A detailed report is contained in publication A/T124, obtainable (price 21s) from the Association at Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

Performance Specification for an automatic keying device for use in merchant ships has been issued by the Post Office. This specification, which is one of the series "Radio for Merchant Ships," is published by H.M.S.O., price 4d.

Correction to "Winds in the Ionosphere," page 188 of May issue. The last sentence of the penultimate paragraph should read: "In the *summer* the wind direction is principally towards the east and in the *winter* months generally south-westerly."

Pye's are lending the two-way radiotelephone equipment for installation in the sailplanes to be used by the British gliding team competing in the World Gliding Championships to be held in Spain this month. The lightweight equipment will enable the pilots to keep in constant touch with their attendant cars.

Microgroove Records are to be made by E.M.I. for distribution in this country. As promised in 1950, the company has given the trade six months' notice of its intention to introduce "records of speeds other than the standard 78 r.p.m." in October.

E.M.I. Sales & Service have appointed W. H. Perkins, O.B.E., M.Sc., lately Director of Education for Warwickshire, as their Educational Adviser in succession to A. C. Cameron, M.C., M.A., who has resigned on medical advice. Mr. Perkins' office is at the Gramophone Co., Ltd., 363, Oxford Street, W.1. (Tel.: Mayfair 1240.)

Decca Radar, Ltd., have formed a new division of the company—Radar Applications Division—which will be concerned principally with the study of marine radar and harbour radar and associated systems, and the planning of installations. R. F. Hansford, late of the Admiralty Signal and Radar Establishment and Sperry Gyroscope Co., has joined Decca to take charge of the new division.

"Design from Britain," the exhibition recently held in Oslo under the auspices of the British Council and the Council of Industrial Design, to boost the prestige of British consumer goods, includes the Pye PE39 short- and medium-wave export receiver.

BUSINESS NOTES

Digital Computor, similar to that installed last July in the Manchester University, has been built by Ferranti for the National Research Council of Canada and will be installed in the University of Toronto. A brief description of the computor, which uses only 3,500 valves compared with the 20,000 employed in ENIAC, was given in our August, 1951, issue.

Ace Radio's new chief engineer is S. F. Wiercinski, who joined the company's laboratory staff in August last year. He was previously assistant to the chief engineer at Rees Mace (Marine), Ltd. Ivor Troostwyk, the managing director of Ace Overseas, Ltd., sole export distributors of Ace products, is on a three months' business tour of the Far and Middle East.

International Aeradio's operations manager, G. R. Scott-Farnie, during his recent 16,000-mile tour of the company's stations in the Far East, arranged for **I.A.L.** to provide air traffic control facilities for the Sarawak Government at Sibu airport. L. M. Layzell, who has joined the staff of I.A.L. from the flight operations department of the Royal Dutch Airlines (K.L.M.), was in the Signals Branch of the R.A.F. on radar during the 1939-45 war.

Falkland Islands, with a population of some 2,000 on the hundred or more small islands south-east of South America, is being equipped with a new 5-kW medium-wave broadcasting transmitter. This Marconi installation at Port Stanley replaces the 45-watt transmitter erected in 1942.

Switzerland's first television station, which is expected to start transmitting very shortly, will use Pye cameras. Five stations are planned for Switzerland—at Zurich, Berne, Geneva, Lausanne and Lugano—which will operate on the standards approved by C.C.I.R., i.e., 625 lines and negative modulation.

Five hundred loudspeakers, grouped in 80 circuits and fed from four 500-watt amplifiers, have been installed by G.E.C. in the tobacco factory of John Player & Sons, Nottingham. In addition, a 60-watt amplifier installed in works in another part of the town is linked by G.P.O. line to the main installation from which it is remotely controlled.

Marconi Marine Installations.—Among the vessels recently equipped with Marconi Marine communication gear and radio navigational aids are the new twin-screw passenger and car-carrying ship *Lord Warden*, to be used by the British Railways between Dover and Boulogne, the 18,400-ton tanker *Eva Peron* and seven trawlers being built in the Hull area. The company has also equipped twenty-nine of the thirty-one vessels comprising Pakistan's merchant fleet. The twenty-fifth ship of the Royal Mail Lines' fleet to be equipped with Marconi Marine radiocommunication and navigational aids is the *Ebro*, a 5,500-ton single-screw cargo vessel. The new 10,000-ton cargo steamer *Romney*, of the Lamport & Holt line, is also fitted with Marconi gear.

Radio Resistor Co., Ltd., of 50, Abbey Gardens, London, N.W.8, have been appointed sole distributors in the U.K. of the electronic components—including high-stability resistors and fixed capacitors—manufactured by Rosenthal Isolatoren of Bavaria.

A consignment of Pye 100-watt v.h.f. transmitters and associated receivers, 15-watt mobile and fixed transmitter-receivers and marine radiotelephone sets was recently shipped to East Pakistan for the police force in Dacca.

British Relay Wireless, Ltd., has appointed as commercial manager of the B.R.W. Group of Companies Barry King, who, during the past seven years, has successively occupied the positions of chief internal engineer and chief planning engineer.

Business Radio v.h.f. equipment has been supplied by Marconi's for ten Swedish tugs. They are fitted with Type H16 transmitter-receivers.

C.R.T. Service.—Standard Telephones and Cables' depots at 5, Oldbury Road, Blackheath, Birmingham, and 87, McAlpine Street, Glasgow, C.3, are now able to exchange "over the counter," defective Brimar television tubes still under guarantee.

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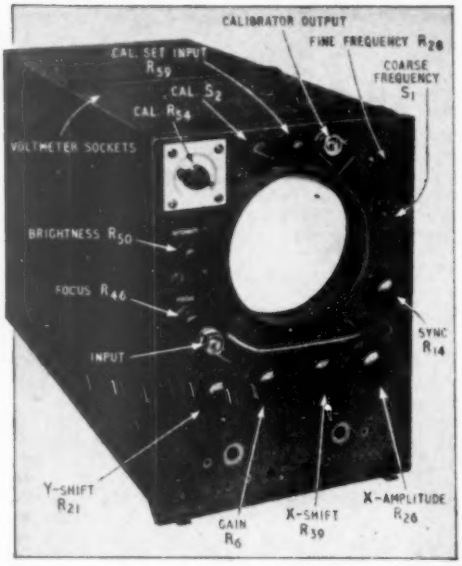


General view of the oscilloscope. The voltmeter for the calibrator plugs into sockets which are accessible through holes in the top of the case.

TELEVISION OSCILLOSCOPE

Simple Design With 5-in Cathode-Ray Tube

By W. TUSTING

AN oscilloscope is used in television mainly for the examination of the waveforms produced by receiver time bases and for checking the operation of sync-separator circuits. The lowest and highest repetition frequencies are 50 c/s and 10.125 kc/s. These frequencies are neither particularly low nor particularly high and, at first sight, there would seem to be no great difficulty in building amplifiers or other circuits to handle them without distortion.

However, it is in their amplifiers and control circuits that so many simple oscilloscopes fail when used in television. For so many years the main occupation of wireless people has been with sound broadcasting that the requirements of sound are often carried over unconsciously into other spheres without proper examination. The simple oscilloscope may well have an amplifier response which is flat within 0.5 db from 50 c/s to 10 kc/s. This appears to be quite adequate for television purposes, but it is not. Such an amplifier is quite useless and grossly distorts television waveforms.

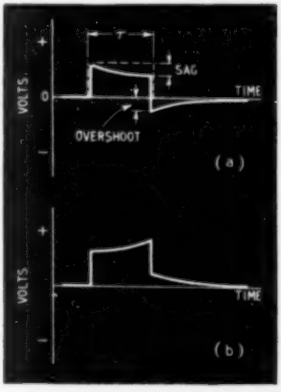
It is, in fact, not very helpful to think in terms of frequency when discussing non-sinusoidal waves and it is much better to think in terms of sags and rise times. Neither of these is very familiar and it is consequently necessary to define their meanings. The sag is related to the amplitude and phase responses at low frequencies, whereas the rise time is related to these responses at high frequencies. Usually they can be considered quite independently of each other.

The dotted rectangle in Fig. 1 (a) represents a rectangular pulse of duration τ. If this is applied as an input signal to an amplifier the resulting output voltage is likely to be of the form shown by the solid line. At the end of the pulse the output voltage sags below the level at the start of the pulse. There is an overshoot equal to the sag and a long trail after that.

The sag is thus the amount by which the output at the end of a pulse falls below the value at the beginning, the ideal pulse being a flat-topped one. In passing, it may be said that a negative sag is possible, but unusual; it means a waveform like that of Fig. 1 (b), where the output rises during the pulse.

The sag is produced mainly by the low-frequency phase characteristic of a circuit but it is usually easier to forget this aspect and to consider it from the point of view of the step response. As an example, the typical RC-coupling of Fig. 2 may be considered. If the grid voltage of the valve is suddenly changed from

Fig. 1. With an input rectangular wave, shown dotted in (a), the output normally tends to the form shown by the solid line. The fall during the pulse is known as the sag. A rise during the pulse (b) is possible with some circuits but is unusual.



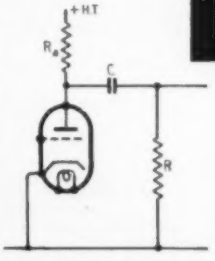
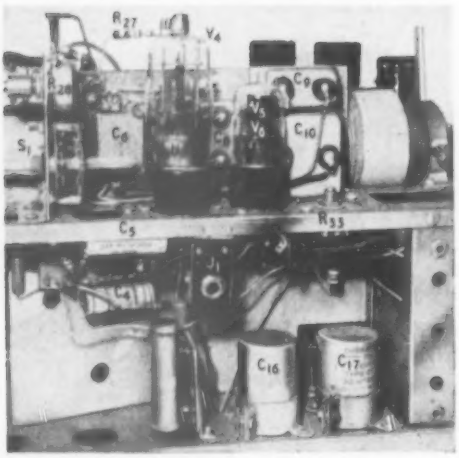


Fig. 2. Typical RC coupling in which the amount of sag depends on the time constant CR.



The time-base is mounted on the upper deck alongside the c.r. tube.

one value to another the anode current changes also and with it the anode voltage. This change is communicated through C, since a capacitor cannot change its charge instantly, and appears across R in its entirety. A voltage across R, however, calls for a current in it and the current demands that C should change its charge. Although the anode voltage of the valve may stay constant at its new value the voltage across R gradually falls; as C, by charging or discharging, provides the current, the current gradually falls and eventually becomes zero. The voltage across R is then also zero and the change of voltage appears fully across C.

Following the initial change of voltage, the voltage across R falls off exponentially from its initial value. The difference between the initial value, when zero time has elapsed after the change of grid voltage, and the value at any later time is the sag at that time. For the circuit of Fig. 2, the sag is given by the very simple expression

$$\text{Sag} = t/RC$$

with t in seconds, R in megohms and C in microfarads. This is an approximate relation which is accurate enough for sags up to about 0.2.

As an example, common values for C and R are 0.1 μF and 1 MΩ where a good low-frequency response is needed. The frequency response at 50 c/s is 0.9995, which seems good enough for anyone. A rectangular pulse repeated 50 times a second has a duration of 0.02 sec, very nearly, if the interval between successive pulses is small. The sag during such a pulse is $0.02/0.1 = 0.2$ so that the output falls by 20% by the end of the pulse. This is gross distortion.

Now let us consider the rise time. This affects the "vertical" edges of the pulse and converts a pulse of the form shown dotted in Fig. 3 into one like the solid line. It often happens that the output rises very slowly at the start and end of the rising part of a pulse, somewhat as shown in Fig. 4. It is then difficult to specify the rise time precisely. To avoid this difficulty the convention has grown up of taking the rise time as the time required to change from 5% to 95% of the final value.

After this digression we are in a position to consider what is needed in an oscilloscope for television. The waveforms of longest period occur in the frame time base and, as the frame fly-back time does not exceed 1.5 msec, the long part of a saw-tooth lasts for 18.5 msec. This is near enough to 20 msec to use the round figure. During this time the sag must be negligible if the picture on the tube face is to be undistorted.

The question now is, "What is negligible?" Suppose we use a 5-in tube and normally have a trace 4 in $\approx$ 10 cm high. Suppose the spot diameter is 1 mm. It is unlikely that we could detect a sag which did not exceed the spot diameter, which means a sag of 1/100 = 0.01. Because of the curved face of the normal tube and other tube distortion this is probably an unnecessarily small figure and it would not be unreasonable to allow a sag five times as great, or 0.05.

The highest repetition frequency is 10.125 kc/s, but the rise time of the leading edge of a sync pulse does not exceed about 0.2 μsec. To obtain this, the oscilloscope response must be at least as good as that of a television set; the 3-db frequency response should extend to about 3 Mc/s! However, without using an expanded trace or its equivalent, one cannot observe such short rise times.

If the time base provides a sweep at 10.125 kc/s so that one line of the television signal is displayed as a trace 10 cm long the duration of the trace is about 100 μsec and we shall be able to detect no change shorter than about 1 μsec. We can content ourselves, therefore, with a rise time of 1 μsec, which means a frequency response to around 0.6 Mc/s only.

The cost, size and weight of an oscilloscope all rise rapidly as the rise time of its amplifier is reduced. Coupling resistors must be reduced in value to increase the rise time. This reduces stage gain and makes more stages necessary which, in turn, makes it more difficult to keep the sag small. In addition, the current taken by the output valves, at least, must be proportionately increased in order to secure the necessary output with lower-value resistors. This means bigger valves and a bigger power supply.

A typical oscilloscope tube needs a signal input of the order of 300 V p-p applied in push-pull, so that the amplifier must have a pair of output valves delivering about 150 V each. The change of anode current in each valve must be 150 divided by the value of the coupling resistor. If this is 5 kΩ, the current

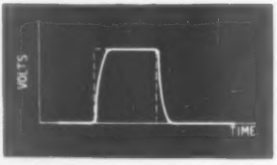


Fig. 3. The effect of the high-frequency characteristic of an amplifier is to affect the edges of a pulse. The ideal pulse (dotted) is transformed to the shape of the solid line pulse.

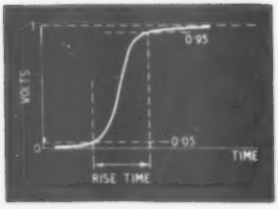


Fig. 4. The rise time of an amplifier is usually defined as the time required for the output to change from 5 per cent to 95 per cent of its final value when an ideal pulse is applied at the input.

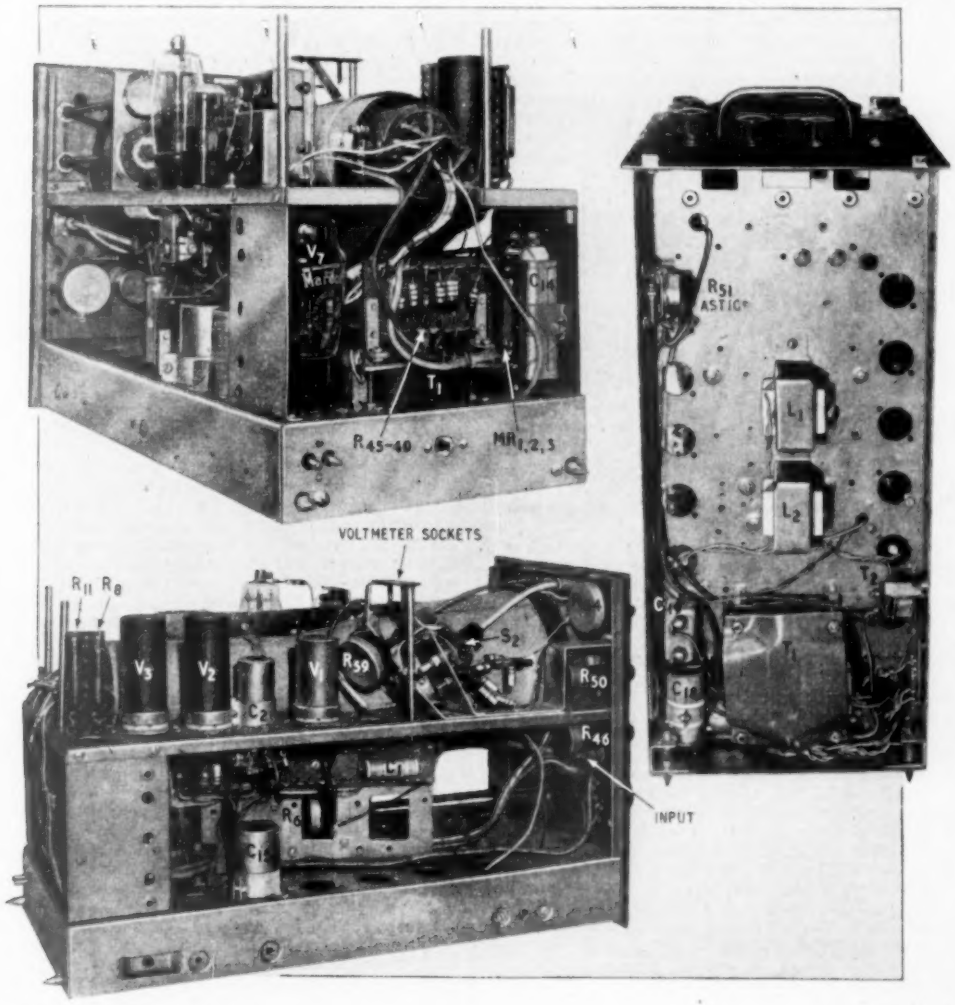
is 30 mA. For good linearity the mean anode current must be appreciably greater than one-half of this and so must be around 20 mA per valve. The circuit capacitance is unlikely to be less than 20 pF. With a 5-kΩ resistance the time constant is 0.1 μsec. This gives a rise time of 0.3 μsec for the one stage. To obtain a rise time of 0.3 μsec in the output stage thus demands a mean current consumption of 40 mA.

This could be reduced appreciably by using compensated couplings, but they add to the complexity and demand careful proportioning if overshoot is to be avoided.

The smallest signal which it is likely that one will want to observe is that existing at the detector of a television receiver, and this is unlikely to be less than 1 volt p-p. A total Y-amplifier gain of around 300 times is, therefore, sufficient and a two-stage amplifier will probably suffice. The largest signal to be viewed will not usually be more than 250 V p-p and so a gain control with a range of 250 : 1 is needed.

On the time-base side, it is desirable to be able to have from one to three cycles of a repetitive waveform visible. In television, three cycles are usually required in order to see one cycle in its entirety, because the "spikes" in television waveforms are usually at the ends of cycles and it is these spikes that govern the synchronizing of the oscilloscope time base. If only one cycle is shown, part is lost in the fly-back. If two

In these photographs the general layout of components can clearly be seen. The rectifier and e.h.t. equipment can be seen under the back of the tube (top left) while some of the power-supply parts are beneath the chassis (right). The signal amplifier and the calibrator are on the upper deck alongside the tube (bottom left).



are shown, one complete cycle is visible but its start and end are not always clearly defined.

This makes the required range of time-base recurrence frequencies 50/3 c/s to 10.125 kc/s, and the time-base linearity should certainly not depart from perfection by more than 5%.

It is necessary to have shift controls so that the trace can be moved to any required position on the screen of the tube. It is very desirable that these controls should be almost instantaneous in their action, for it is very irritating to find that after altering one of them the trace drifts slowly across the screen. A common practice is to use RC coupling to the deflector plates of the tube and to obtain the shift voltages from potentiometers in the e.h.t. supply. If the time constants of the couplings are made large enough for an adequately small sag on a 20-msec pulse, then slow-acting shift controls are inevitable because the shift voltage necessarily requires that the mean charge on the capacitors be altered. To obtain quick-acting controls it is necessary to use direct coupling to the deflector plates and to apply the shift via the amplifier.

There are, of course, many ways in which the requirements for television can be met and the description which follows of an oscilloscope which the writer has made for this purpose illustrates one solution to the problem. In its mechanical form, the oscilloscope was based on a piece of surplus equipment, the American Loran Indicator Unit, Type AN/APN4, but only because the chassis and case were convenient for the purpose. No use whatever was made of any existing circuitry and the whole chassis was completely stripped as a start. Some of the components were used, mainly capacitors and resistors, and the tube, a Type 5CP1.

The precise layout of the components was dictated to some extent by the form of the chassis and so no useful purpose would be served by giving measurements. It is unlikely that there are many of these Units now available; the writer's was bought several years ago. A British equivalent to the 5CP1 tube is the Mullard DG 13-2, but the design is, in general, not restricted to this tube type and any form of oscilloscope tube can be employed without any great modification being required.

The main peculiarity of the 5CP1 and DG 13-2 tubes lies in having a post-deflection accelerating electrode so that up to 4 kV can be used to obtain a very bright trace with a deflection sensitivity much the same as that of a normal 2-kV tube. No use is made of this and the electrode is operated at about 2 kV being, in fact, connected to the final anode, for the brightness at this voltage is amply sufficient.

(To be concluded)

Measuring High Resistance

The Guard Ring Technique for Eliminating Surface Leakage Errors

By M. G. SCROGGIE, B.Sc., M.I.E.E.

SEVERAL readers have written to enquire where they can find information on the guard ring technique mentioned in connection with the valve voltmeter described in the January issue (p. 18). It is in most of the textbooks on electrical measurements, but not usually in literature dealing with radio applications, so a few notes may be helpful.

The object of a guard ring is to confine a resistance measurement to the path required to be measured. There is usually no need for special precautions with low and medium resistances, because parallel leakage paths can be neglected. But with very high resistances, such as insulation, one has to consider exactly what it is one is measuring. This problem arose in the last century, when it began to be necessary to measure the insulation resistance of cables. One electrode for making contact with the insulation was, of course, ready made—the inner conductor. If it was an armoured cable the outer covering could be used as the other electrode; if not, the sample was immersed in salt water to make good contact with the outer surface of the insulation. In either case the sample was connected in series with a high-voltage battery and a sensitive galvanometer. Obviously, the galvanometer had to be shorted out while the battery was being connected, for the sample was in effect a capacitor, and the momentary charging current would usually be vastly greater than the leakage current through the insulation. The galvanometer was provided with a variable shunt, and unshunted cautiously.

With this straightforward arrangement, shown in Fig. 1(a), the galvanometer would read not only the current passing through the cable insulation but also some going over its surface at the ends of the cable where the connection was made. This leakage path, shown dotted, would naturally be quite short, and the current passing that way might well be a considerable proportion of the whole, invalidating the measurement.

Since these two paths are permanently in parallel with one another, it might seem difficult to measure the current through one of them only. But the solution is very simple: a wire is tied round the cable insulation as near the ends as possible, forming a "guard ring," which is connected straight to the galvanometer side of the battery, as shown in Fig. 1(b). Surface leakage current between this guard ring and the water does not pass through the galvanometer; and there is no battery to drive any current through the galvanometer via the leakage path between guard ring and inner conductor. This leakage path forms a shunt to the galvanometer, but normally its resistance would be far too high to affect the reading appreciably. So the only current driven by the battery

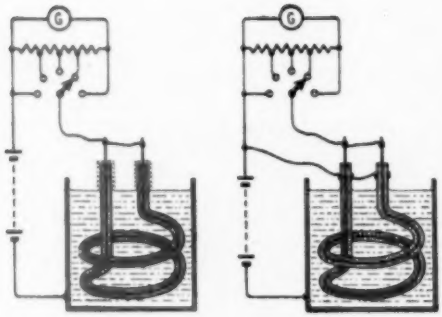


Fig. 1. Without special precautions (a), the measurement of high resistances such as cable insulation is subject to error due to parallel leakage paths, shown dotted. Provision of a guard connection (b) excludes this source of error.

through the galvanometer is what flows through the cable insulation, and everything is as it should be.

Fig. 2 shows the principle more generally. R denotes any high resistance to be measured, and R_L is any unavoidable leakage. Some of R_L may belong to the thing being measured (such as surface leakage at the ends of a cable), and some of it may be inside the resistance-measuring apparatus itself. If no precautions were taken (a) the measurement would be unreliable. So the apparatus, whether set up as required from separate units or permanently wired up in a box, ought to be provided with a guard system as shown dotted (b). The high-potential terminal (from the galvanometer's points of view), 2 in Fig. 2(b), is surrounded by a guard ring; and a third terminal, 3, is provided for connecting to any external guard ring that may be necessary. If any earthing is to be done, this would be the terminal for it, as it would keep the galvanometer at earth potential.

Looking at Fig. 2(b) one can scarcely help thinking of the dotted guard as a screen. From the purely d.c. point of view this is hardly correct, because air is such a good insulator that leakage through it can generally be neglected, even for insulation measurements; so it is only around solid insulation that a guard is needed. But in practice one finds that it is an advantage for the guard to be in the form of a continuous screen, because with very high resistances, of the order of millions of megohms, capacitive effects are a nuisance unless screening is provided. Even moving the hands about near the apparatus varies the electric field pattern and causes small charging currents to pass through the indicator.

Most of us, electronically minded and shallow-pocketed as we are, do not go in for the super-sensitive galvanometers beloved of the classical electricians. Apart from anything else, we are stricken by the thought of what would happen in the kind of set-up just described if the insulation were to break down. So we rig up a valve voltmeter circuit, possibly with a cheap Government-surplus milliammeter as the indicator. Actually, as emphasized in the valve-voltmeter article previously mentioned, the valve has to be carefully selected for type, and perhaps individually; and it must be operated with low heater and anode voltages and minimum anode current. But even if one goes the length of buying a relatively expensive electrometer valve it is cheaper and far less hazardous than a galvanometer.

The usual circuit begins something like Fig. 3, where the terminal numbering is the same as before. 500V is the standard for general insulation resistance measuring. Terminal 1 and the range switch must, of course, be very highly insulated. Supposing the highest range resistance is 10,000MΩ, then an indication of 0.5V is obtained through one million megohms. It is important that the test voltage be very thoroughly stabilized, especially when measuring the resistance of capacitors.

But it is not the intention just now to give details of the measuring equipment. The present subject is the guard-ring technique and would be incomplete without some reference to the testing of insulation samples for volume and surface resistivity.

In the classical method the sample is floated on mercury, and upper electrodes (inner and outer) are also formed of mercury. But since mercury is unpleasant stuff to have around (the vapour from a mere drop of it inside an instrument case causes all the soldering to disintegrate), and necessitates rather special brasswork to hold it into the prescribed shapes on the top of the sample, the British Standard tests allow one the alternative of painting electrodes on to the sample with graphite. Volume resistivity is determined by measuring the resistance between circular electrodes on each face of the sample. If R_v is the resistance, ρ_v (the resistivity) is $R_v A/t$, where A is the area of

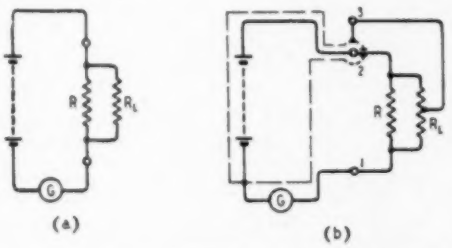


Fig. 2. Here the resistance to be measured is denoted by R and undesired leakage paths by R_L. (b) shows a complete guard system.

Right: Fig. 3. How a guard ring can be applied when the measuring instrument is a valve voltmeter.

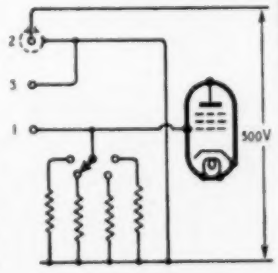


Fig. 4. Standard connections for measuring volume resistivity of a sample of material. The numbering applies to both Figs. 2 and 3.

Fig. 5. Connections for measuring surface resistivity.

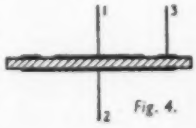


Fig. 4.

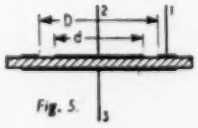


Fig. 5.

each (or the smaller) electrode, and t the thickness of the sample, in centimetres or metres, according to whether one is a follower of the c.g.s. or m.k.s. system of units. To exclude the effect of surface leakage via the edges, a guard ring is painted around the upper electrode; and the connections are as in Fig. 4. The test voltage exists between 1 and 2, but there is negligible voltage between 1 and 3 to cause leakage current over the surface. The sample should not be thicker than necessary, or there will be error due to the area of conduction spreading.

Surface resistivity is more a measure of the weather than of the material, for it varies at least a hundred times as fast as the relative humidity of the atmosphere; but where this is accurately controlled there may be some sense in making the measurement. The problem is to measure the leakage path across the surface while excluding so far as possible conduction through the volume of the material. To do this, the sample is connected as in Fig. 5. Here the test voltage exists across the surface between 1 and 2, but not round the edges or through the material between 1 and 3. If R_s is the measured resistance, ρ_s is $2\pi R_s/\log_e (D/d)$. To exclude volume conduction, the difference between D and d ought to be not less than six times the thickness of the material; but even so, it is normally small enough for one to use the approximation $\pi R_s(D+d)/(D-d)$ without serious error. It makes no difference what units the distances D and d are measured in (so long as the same units are used for both).

It must be remembered that the resistivity of insulators and semi-conductors varies not only with atmospheric moisture but also with temperature and test voltage. Checking the insulators and materials around one's laboratory is likely to be a real eye-opener. It is possible to find that an insulator used to keep connections from contact with the wood base may actually conduct more readily than the wood! And the desirability of keeping apparatus warm and dry can be strikingly demonstrated, even in the temperate climate of Great Britain.

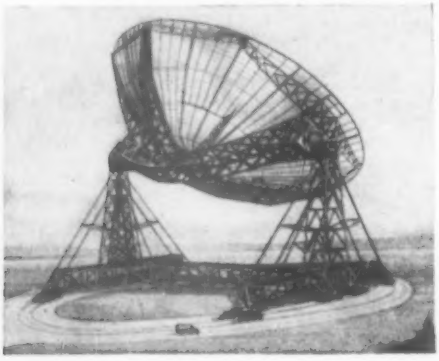
Giant Radio Telescope

250-ft Steerable Paraboloid for Exploring the Radio Cosmos

NOT long after the establishment of a Chair of Radio Astronomy at Manchester University comes the news that a giant radio telescope (the biggest in the world) is being built for the University at its radio astronomy experimental station at Jodrell Bank, Cheshire. It will cost somewhere in the region of £336,000, half of which is to be paid by the Nuffield Foundation and the other half by the Department of Scientific and Industrial Research.

Jodrell Bank already has quite a large paraboloidal radio telescope (220 ft), but as this is fixed to the ground the beam can only explore the small strip of sky across which it is swept by the rotation of the Earth. Thus the radio astronomers may have to wait perhaps all the year round for the beam to get to the particular section of sky in which they are interested. The new radio telescope will avoid all this, for the paraboloid will be mounted so that it can be swung through a complete circle in both azimuth and elevation to steer the beam in any direction required. The steering is to be done by an extremely complex automatic remote control system, which will bring the beam to fixed positions, make it follow the course of a radio star, or produce a kind of scanning "raster" across an area of sky. The speed of movement of the beam will be continuously variable from 2 degrees per hour to 36 degrees per minute.

Drawing of the new steerable radio telescope as it will appear when completed. A motor lorry is in the foreground.



Considering the enormous size of the paraboloid, this steering facility will be something of an engineering achievement. The platform on which the structure rotates will be 310 ft across, and when the beam is directed horizontally the top rim of the paraboloid will be 300 ft from the ground. Trafalgar Square, London, would just about accommodate the base of the telescope, but Lord Nelson on the top of his 175-ft column would be put somewhat in the shade!

The great size of the paraboloid is necessary partly to achieve high gain (for the incoming signals are extremely weak), and partly to give a narrow pencil beam (about 2° wide) capable of separating radio stars very close together. Signals from these radio stars are like noise in character and cover an extremely wide range of frequencies, but only those with wavelengths between about 3 centimetres and 30 metres can actually get through to us because of absorption in the atmosphere at one end of the band and the blocking effect of the ionosphere at the other. The radio telescope will be able to look through this "window" on a band of wavelengths between 1 and 10 metres.

When the telescope is completed it will be applied first to the study of radio stars, in our own galaxy, the Milky Way, and in other galaxies. Later it will be used as a radar aerial for exploring the moon and some of the nearer planets.

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VALVE LIFE TESTING

Standard Equipment Adaptable to Various Types

By R. BREWER *

IT may not be generally realized that manufacturers of radio valves conduct extensive and regular life tests on samples of their products. This is done to determine the service which the ultimate users may expect to receive from the valves, and to obtain accurate information regarding the way in which valve characteristics as a whole change throughout life. Information of this kind is very difficult to obtain during the actual use of the valves since, in most of their applications, they are just one of the many circuit elements needed to convey a radio signal. Unless valves are examined as a circuit element, independently of the circuits in which they are used, it is impossible to obtain that information concerning them which is essential for improving their life performance.

When equipment is running normally, few users are prepared to check all their valves periodically merely in order to gauge how their characteristics are changing. It is only when a fault occurs that the valves are checked. Generally the length of time which the valve has been working, its operating conditions throughout the time, and the possible association of the valve fault with the failure of other components, are all factors either altogether unknown or only roughly estimated.

Fig. 1. Receiving valve life-test bays.

Factors of this kind considerably influence the life of a valve, but because they are usually imperfectly known the potential evidence from valve failures in use is seldom fully available to the manufacturers.

Valve makers rely upon their own life tests to obtain information about valve behaviour in use, great care being taken to ensure that this information is as reliable as possible. There must be no doubt that a valve which fails on test has become defective and has not failed as a result of an equipment fault or a deviation in operating conditions. Life-test evidence which is suspect, or which the production engineer feels he cannot use with confidence, is valueless. This requirement for the results obtained to be of the utmost reliability is that which most strongly influences the design of all radio valve life-testing equipment. It is essential for the equipment to possess an order of reliability better than that of the valves under test.

From the safety aspect also, equipment reliability is of great importance. Life-testing time is reduced to a minimum by operating the plant 24 hours a day and seven days a week, and designing it to require the least possible amount of supervision. Fire hazards, in particular, have to be reduced to a negligible minimum by sound equipment design. The way in which these various factors have been taken into account can best be illustrated by reference to the new installation at the G.E.C. Research Laboratories at Wembley, where life tests on Marconi and Osram valves are conducted.

Receiving valves are tested in double-sided racks as shown in Fig. 1. Completely independent bays of equipment are mounted back-to-back on each frame, providing a total capacity for 96 valves on approximately 2 sq ft of floor space. Power supplies are carried over busbars running along the tops of the racks and the incoming supplies are converted to potentials appropriate to the valve electrodes by equipment housed in the two lower panels. Heater supplies

* Research staff of the M.-O Valve Company at the G.E.C. Research Laboratories, Wembley.

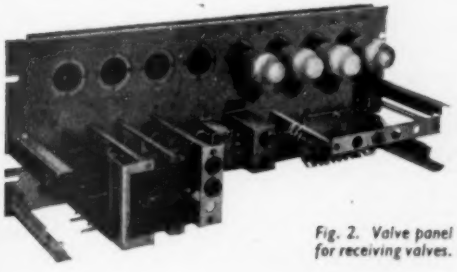


Fig. 2. Valve panel for receiving valves.

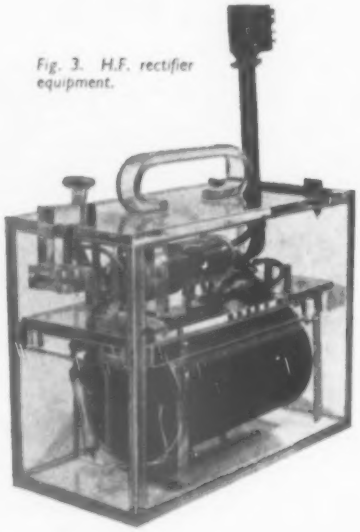
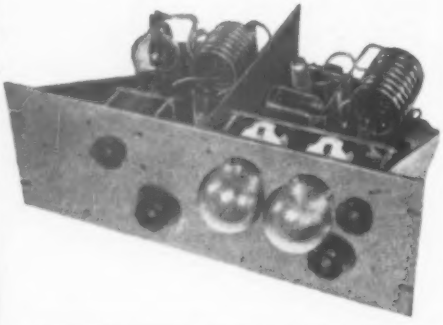


Fig. 3. H.F. rectifier equipment.

Below : Fig. 4. Transmitting valve panel.



are derived from a 240-V 50-c/s regulated motor-alternator set which is used for life-test purposes only.

The front of each bay is fitted with a heater transformer which supplies all the valves on the bay. Anode, screen, heater-cathode and other d.c. supplies are provided by motor-generator sets, potentiometers on each bay being used to produce the required electrode potentials.

The valves on test are placed in the six panels which occupy the main central area of each bay. The valve panel, shown in Fig. 2, is the "heart" of the system. It is specially designed so that it is capable of running most types of receiving valves with a minimum of conversion. Although a valve manufacturer may market perhaps 200 types of receiving valves, only a small proportion of these types are in manufacture at any one time. Nearly every type of valve requires life-test equipment which differs in some way from that needed by other types. If, therefore, equipment were to be available to cover the whole range of types produced, the larger part of the total life-test facilities would always be idle. This problem is met by mounting the valve holders and their immediate wiring in a removable sub-panel and making the permanent supply and control wiring adequate for all needs. Conversion from one type of valve to another thus necessitates only the exchange of the sub-panel.

Immediately above the upper row of valves in Fig. 1 are seen two panels which house the bay switching and fault-indicating equipment. Coloured lamps on each bay denote the incidence of a blown fuse or the occurrence of a heater-to-cathode short circuit. The heater-cathode fault lamp is operated by a relay, the coil of which is in series with the supply which maintains the heater-cathode potential difference. When a heater-cathode breakdown occurs in any valve on the bay, current flows through the relay and a limiting resistor, and the fault lamp lights. Since this indication may have been caused by a fault in any one of the 48 valves running on the bay, the next stage is to isolate the defective valve without having to remove more than a minimum number of the remaining 47 valves. This is done by fitting a press switch in the line carrying the total cathode current of each valve panel. Operation of this switch on the appropriate valve panel breaks the relay coil circuit and extinguishes the fault lamp, thus limiting the search to within eight valves. These are removed in turn until the defective one is found.

The life-test equipment described has proved to be extremely adaptable in testing a wide variety of valve types under many different operating conditions. In addition the amount of maintenance work needed by the installation in over three years' continuous use has been extremely small. Further, the equipment has easily fulfilled the life-test requirements of many new types of valve that were not in existence when it was first designed.

Testing Rectifiers

Rectifiers are tested in panels accommodating four valves, each of which has its own h.t. transformer, capacitor and resistor elements which form the load. A single transformer supplies heater power for all the valves on a bay. By this means precise control of heater voltage is effected without the necessity of a large number of individual adjustments.

The high-frequency type of rectifiers used in television receivers are life tested in the equipment shown in Fig. 3. A Perspex box houses the valve on test, its h.t. transformer, load resistor and capacitor. All components are immersed in oil to avoid possible deterioration of the test equipment, and to ensure absolute safety for the operators. The filaments of the rectifiers are heated by a 1.4-V 50-c/s supply which is more convenient for routine measurement and control than h.f. power. The latter, which is derived from a valve oscillator associated with each box unit, is used for the anode supply.

Transmitting valves are run in typical oscillatory circuits, the precise running conditions being determined by the specification of each valve and the service for which it is intended. Some of the test conditions for transmitting valves involve the use of a considerable amount of auxiliary equipment. This factor plays a large part in the design of this class of life-test unit since it is essential that the life-test report for each valve shall refer to the valve alone,

and should be independent, as far as possible, of changes in the associated equipment.

The wide range of frequencies for which the smaller types of transmitting valves are used makes it difficult to standardize the design of their life-test equipment. Circuit techniques change markedly with frequency, and the diversity of valve power dissipations and cooling methods means that each type of transmitting valve requires its own specially designed piece of life-test gear. A further consideration is that of the operators' safety. The higher voltages and powers involved in testing transmitting valves make it necessary to use automatic protection devices which prevent access to all dangerous parts of the equipment until the power has been switched off. By constructing all test sets on standard panels 19in wide, however, and mounting them in a standardized form of h.t. safety enclosure, a satisfactory degree of unification has been achieved.

Fig. 4 shows a typical life-test panel in which a small transmitting pentode is tested as an amplifier in the Class C condition at a frequency of 25 Mc/s. The valve on test, its oscillatory circuits and driving valve are mounted on the platform at the back of the panel, the controls and load lamps appearing on the front of the panel.

The test panels are housed in bays built to form h.t. enclosures similar to that illustrated in Fig. 5. The valve panels are mounted on the sides of the enclosure. The safety gate is placed in the front partition and is flanked on either side by the control panels of the power units which are permanently housed inside. The whole equipment operates from a 240-V 50-c/s regulated supply, the gate switch preventing the power units from working until the gate is closed. The valve test equipment extends from the top of the framework to within about 2ft of the floor, the power rectifier units occupying the remainder of the space.

To prevent the free radiation of r.f. energy, the whole of the transmitting valve life-test equipment is installed in a screened room, formed by enclosing a layer of copper mesh in walls, floor and ceiling during construction. Each h.t. enclosure derives its a.c. power from a special transformer and filter unit which stops r.f. power from life-test sets reaching the mains.

It may be noted that for life-test purposes high-power audio frequency valves are tested in the same manner as transmitting valves owing to the similarity of their voltage and power demands. These valves are tested at a fixed audio frequency, the output being absorbed by a dummy load.

Checking Operating Conditions

An instrument trolley is used for setting or checking the operating conditions of valves on life test—a routine which is carried out daily. Apart from economic considerations, the trolley system is preferred to built-in meters on account of the much greater ease with which instrument checks may be made. All valve life-test evidence ultimately depends upon instrument measurements, so it is important to maintain the required standard of accuracy of the instruments in order to get reliable information.

In addition to the instrument trolley checking, the operating conditions of receiving valves during life test can be automatically checked by a specially developed "routiner." This instrument draws the attention of the operator to the small number of circuits needing adjustment, thus cutting out the alternative and much more lengthy process of tracing the faulty circuits.

The essential unit in the "routiner" is a precision relay which operates on either a.c. or d.c., and is capable of completing an alarm circuit when the voltage across the relay coil changes from a reference figure by more than 1 per cent. The instrument is fitted with two contacts on either side of the moving armature, the latter being held in the mean position

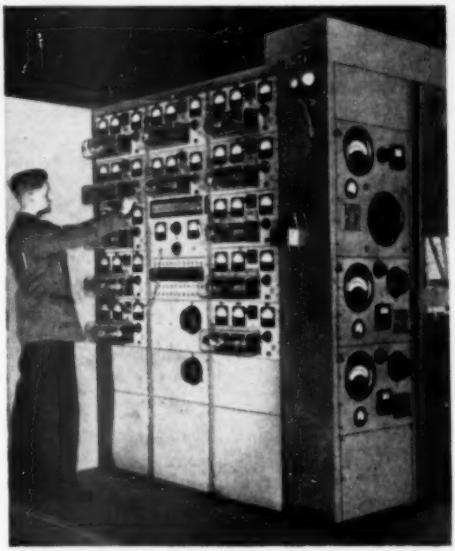
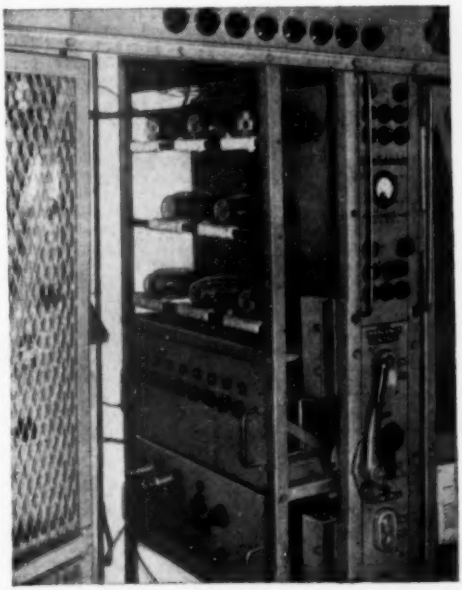


Fig. 5. H.T. enclosure for transmitting-valve life tests.

Fig. 6. High-power audio output valve equipment.



by a potential difference of 10 volts across the coil terminals. If 10 volts can be derived from each bay circuit to be tested, when the circuit is correctly adjusted, a change in any circuit of more than 1 per cent will cause the relay to operate and an alarm lamp to light. The relay is connected in turn to the test circuits by means of a two-motion selector switch, a capacity of 500 test lines being available.

Arrangements can be made for changing the sensitivity of the "routiner" when testing different groups of lines. This enables variations of up to 10 per cent (instead of the normal 1 per cent) to occur before an alarm is shown. These wider variations are naturally only allowed on those electrode supplies which affect the life of a valve less critically.

The "routiner" is used principally for testing heater voltages, h.t. electrode voltages, rectified load current, and the occurrence of broken filaments in battery-type valves. Controls available include manually operated keys for stepping the switch to any desired circuit, and a retest key. The latter enables the operator to repeat the test on any circuit which has stopped the "routiner" if a transient fault is suspected. The "routiner" can be set to run a single cycle, or to work continuously until a fault is found.

To simulate typical operating conditions, receiving valves are switched on and off throughout their life test. The switching impulses originate in timers on a central switching bay, a uniselector distribution unit being used to switch all the life-test bays in succession. This arrangement avoids the surges on supply lines which would otherwise occur if the full life-test load were switched simultaneously. A typical switching programme is to run valves continuously for the twelve day-time hours followed by a five-minute off period in each of the twelve night hours. Day-time switching would interfere with the work of placing valves on the test racks and making the necessary measurements.

The valve life-test installations which have been described handle approximately 6,000 valves of all types each year. The work of the group responsible for life-testing valves can be regarded as falling into two distinct categories. One section is employed in making measurements, analysing results and preparing information for reports, while another section is responsible for the design, installation and maintenance of the equipment, together with the development of new life-testing techniques. While routine tests on standard products are proceeding continuously, a large part of the work is concerned with testing valves of an experimental nature. The work of the group therefore contributes towards the fundamental research carried out on valves and associated topics. Valve makers are continuously concerned with improving the design, manufacture and performance of their products, and the life-test report is the best indication of the results of their endeavours.

MANUFACTURERS' LITERATURE

Interference Suppression capacitors and filter units for incorporation in electrical equipment, catalogued in an illustrated folder from the Dubilier Condenser Co., Ltd., Ducon Works, Victoria Road, North Acton, London, W.3.

Negative Feedback Amplifiers and pre-amplifiers with tone control; their design and application in equipment for high-quality reproduction, with particular reference to the Leak "Point One" series. An informative and well produced booklet, including a comprehensive bibliography, from H. J. Leak and Co., Ltd., Brunel Road, Westway Factory Estate, London, W.3.

Television Components suitable for use with wide-angle c.r.t.s; informative and well-produced catalogue available to manufacturers from The Plessey Co., Ltd., Ilford, Essex. Also a catalogue of **Loudspeakers.**

Spot Wobbler unit for television receivers; brief description on a leaflet from Aren (Radio and Television), Ltd., High Street, Guildford, Surrey. Similar leaflet describing their 8-12kV r.f. **E.H.T. Unit.**

Capacitors by T.C.C. Technical bulletins on the following: miniature moulded silvered mica; "Cathodray" high voltage; "Picopack" miniature electrolytics; "Plimoseal" finish for stacked mica and silvered mica; "Electroflash" electrolytics for electronic flash photography; electrolytics for high-temperature working. From The Telegraph Condenser Co., Ltd., North Acton, London, W.3.

Consol Navigational Aid; booklet for prospective users, containing general description and operational data, from The Marconi International Marine Communication Co., Ltd., Marconi House, Chelmsford.

Multi-outlet Television Pre-amplifiers described briefly on a leaflet from Rainbow Radio Manufacturing Co., Ltd., Mincing Lane, Blackburn.

Unit Television Aerial; standard components that can be put together in various ways to form different kinds of arrays, described in leaflets from Ladybird AMI, 27, Whitcomb Street, London, W.C.2.

Magnetic Recording Tape; descriptive leaflet and price list from the Minnesota Mining and Manufacturing Co., Ltd., 167, Strand, London, W.C.2.

Neon Tester for one-pole tests on a.c. or d.c. mains; a leaflet from Grafton, Kersten & Co., Ltd., 77, South Audley Street, London, W.1.

NEWS FROM THE CLUBS

Birmingham.—"Practical Accelerators and their Electronics" is the title of the talk to be given by J. Y. Freeman, of Birmingham University, to members of the Slade Radio Society on June 6. The following meeting (20th) will consist of a direction-finding test with instruction for beginners. At midnight on June 28/29 the club will be participating in the d.f. test being organized in connection with the Midland Amateur Radio Society's "Field Week-end." The club meets on alternate Fridays at 7.45 in the Parochial Hall, Broomfield Road, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Brighton.—The lecture at the meeting of the Brighton & District Radio Club on June 24 will be given by F. E. Lane of the Tungsram Valve Co. Meetings are held every Tuesday at 7.30 at the Eagle Inn, 125, Gloucester Road, Brighton. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton, 7.

Coventry.—A talk on "C.W." will be given by L. Gardener, G5GR, (chairman) to members of the Coventry Amateur Radio Society on June 9. The club meets on alternate Mondays at 7.30 at the Y.W.C.A., Queen's Road, Coventry. Sec.: K. G. Lines, 142, Shorncliffe Road, Coventry.

Southend and District Radio Society has undertaken to erect and man a transmitter and provide associated equipment for the Scouts' Jamboree at Belchamps, Hockley, Essex, from August 9-16. Sec.: G. Chapman, Bell Hotel, 20, Leigh Hill, Leigh-on-Sea, Essex.

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FURTHER NOTES ON

THORN NEEDLES

A Quantitative Contribution to an Old Controversy

By S. KELLY*

SOME months ago, my interest in thorn-type styli was re-awakened by an article written by Mr. Pollock.[1] It had always been my opinion (confirmed by a series of experiments several years ago) that thorn styli suffered from two serious faults: (a) the high-frequency response was considerably reduced relative to a semi-permanent stylus, say, of sapphire or diamond, and (b) the thorn stylus required sharpening at frequent intervals and under some circumstances would not last one side of a 12in record.

At the time these experiments were performed, the pickups experimented with were what were then termed "lightweight." They required a tracking pressure of 25 gm, and had an upper resonance of round about 14 kc/s, and a low frequency of 20 c/s.

Mr. Pollock's article shook me out of my complacency—especially as the facts could not be reconciled—a stylus tip of approximately 0.001in diameter should not trace satisfactorily a record groove of considerably greater dimensions, and the high-frequency cut-off should be considerable; but as the results claimed were purely subjective a quantitative investigation was decided upon.

Stylus Dimensions

A moving-coil pickup supplied by Mr. Pollock was used for the tests, and to establish a common point two frequency response curves were taken, using sapphire styli. The styli were 0.29in long and 0.21in long, respectively (for convenience called the "long" and the "short" sapphires). The sapphires used were checked for radii and found to be 0.0025in ±0.00005in. The polish and general finish, viewed under a Beck binocular microscope with a magnification of ×87, was good. The thorns, which were obtained from Mr. Pollock, were also checked: as received, and after playing the first and both sides of Decca K2069 "Danse Macabre." One of the sapphire styli was used for comparison, and the dimensions of the thorn as received agree with the photo-micrographs of the December, 1950 issue of *Wireless World*.

The response of the pickup using the sapphire styli is shown in Fig. 1. The response agrees well with accepted theory, and it is seen that the upper resonance, using the "short" sapphire, is above 20 kc/s, and the maximum variation from an ideal curve is of the order of 3 or 4 db. The "long" stylus gives a resonance at 16.5 kc/s.

The sapphire styli were then replaced by thorn styli of three different lengths: 0.39in ("long"), 0.31in ("medium"), and 0.21 ("short"), and the frequency response of the pickup is shown in Fig. 2. Here it will be seen that, as expected, the resonant frequency is considerably reduced, and with the "long" stylus comes at about 7.5 kc/s, which is too low for its effect to pass unnoticed. The amplitude of the resonance is also considerable, the "long" stylus showing a peak of almost 20 db, and the shorter styli giving reduced amplitude of the peaks, which is to be expected.

Cantilever Mounting

Fig. 3 shows the response of thorn styli 0.062in long, cemented in the end of a cantilever stylus. The tracking weight of the unit was adjusted to 10 gm, and the

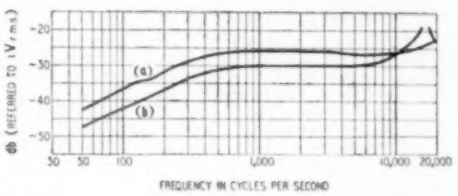


Fig. 1. Frequency response curves of moving-coil pickup (a) with "short" stylus (0.21in) and (b) with "long" stylus (0.29in).

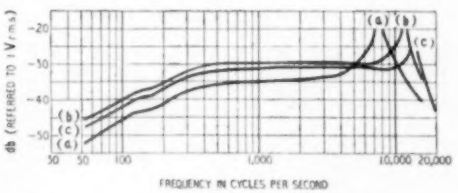


Fig. 2. Frequency response of the same pickup with three thorn styli, (a) "long" (0.39in), (b) "medium" (0.31in.) (c) "short" (0.21in).

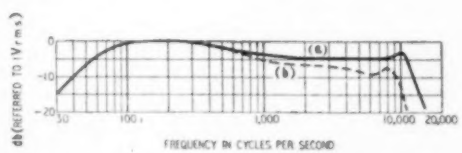


Fig. 3. Response of cantilever crystal pickup (a) with normal short sapphire stylus (b) with thorn stylus, 0.062in long, cemented in place of the sapphire.

* Cosmocord, Ltd.

[1] *Wireless World*, December, 1950.

maximum life obtained was seven sides of "Danse Macabre." The moment of inertia at the stylus tip using the thorn styli was within 10 per cent of that using the sapphire.

The E.M.I. JG 449 test record, used for the response measurements, is a spot frequency disc and it is possible that minor wiggles may have passed unnoticed; the deviation from the ideal response at about 150 c/s in the curves of Fig. 2 was not investigated and no comments are offered, as it is not thought to be relevant to the present discussion.

It was found that reliable readings with newly pointed thorns could not be taken because the shape is such that intimate contact with the groove walls is not obtained until the point is worn to a chisel point.

The above measurements were made on a pickup connected to a valve voltmeter through a correctly loaded matching transformer. The tracking weight was adjusted to 10 gm, and the results recorded after one complete run on the JG 449 with the "long" and "medium" styli and after the fourth run with the "short" stylus. The stylus was visually checked under the microscope before and after each run, and it was confirmed that consistently repeatable results were not obtained until the thorn had achieved a wedge-shaped profile.

The pickup was then checked on the E.M.I. intermodulation test record JH 139 on side 400-4,000 c/s.[1] It was only checked with the "long" and "short" styli and the mean of the response corresponding to 10 per cent intermodulation distortion was reached at a level, referred to a groove velocity of 1 cm/sec, of 12.5 db on the "long" stylus and 20.5 db on the "short" stylus. The pickups were then given subjective tests, being connected to a correctly equalized amplifier-speaker system. The "Danse Macabre" was used as a test record, and it was found that the surface noise was not unduly coloured using the "long" stylus, but the violin tones were extremely harsh, even when the treble was cut 10 db at 10 kc/s. With the "medium" and "short" styli, the violin tone showed progressive improvement, but was not clean.

Using the "long" sapphire stylus, the surface noise had a marked high-frequency coloration, and the violin tone was comparable with the results obtained with the "short" thorn. With the "short" sapphire, the surface noise had no discernible coloration and sounded truly "white"; the violin tone here was very clean and on other audio tests gave the best results.

No tests were made on long-playing records.

[1] For a detailed discussion of intermodulation testing of pickups the reader is referred to an article in the July, 1951, issue of *Wireless World*.

Playing Time

The maximum playing time which could be obtained before marked deterioration of quality was apparent was between three and seven sides of a 12in record. It cannot be ascertained whether this was due to minute differences in stylus shape and the included angle, or variations in the stylus material.

The experiments confirmed the generally accepted view that thorn styli for use with low mechanical impedance pickups can give a reasonably extended frequency response, but at a cost of changing the stylus frequently and the tedium of re-sharpening.

Wear tests on records were not attempted in this experiment, but on the previous experiment with a 25-gm pickup, and replacing the stylus after every side, wear was apparent after approximately 200 sides had been played, using the second side of "Danse Macabre" as the test record.

In conclusion, I would like to thank Mr. Turville for his help in these experiments.

At the Editor's invitation the following comments on Mr. Kelly's findings have been contributed by Mr. A. M. Pollock, author of the original article in the Dec., 1950, issue.

I AM very appreciative of the trouble Mr. Kelly has gone to in following up with laboratory experiments the ideas I expressed on the merits of thorn styli in suitable modern pickups.

I have not myself been able to obtain quite as severe peaks, but this may be because I use a gliding-tone test record whereas Mr. Kelly's curves were plotted from points taken under steady-state conditions.

A point of some value illustrated by the curves is, I think, the fact that the vibrating system has to be considered as a whole when discussing the performance of a pickup. This should, of course, be obvious enough, but a variation in resonant frequency *of the same pickup* from 7.5 kc/s to over 20 kc/s may be rather more than many would have expected. Also it is of interest to note that an apparently small change in the length of a sapphire stylus from 0.21in to 0.29in alters a very desirable characteristic into one with marked high-frequency coloration and, as Mr. Kelly says, noticeable harshness in the reproduction of music.

The tests suggest that, for the best results, the thorn should be reasonably short and users can no doubt meet this requirement by keeping new thorns of the maximum length for their older or lower quality recordings where some top cut may be necessary anyway. Also there seems to be room for experiment by individual users in the acuteness of the point to give the best compromise between acceptable life and good groove fit.

I think it not unfair to suggest that Mr. Kelly's results bear out my general proposition regarding the possibilities of thorns under favourable conditions. One has still to remember the great variations in quality of commercial records and, as I have said before, these variations tend, in my experience, to swamp the smaller differences between thorn and sapphire reproduction at domestic sound levels in similar grades of pickup.

Finally, as a matter of record, I should perhaps mention that the output characteristic given in my letter published in the April, 1951, issue was taken with a different pickup from the one used by Mr. Kelly. The latter was an improved model with much lighter coil.

A. M. POLLOCK.

Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

Coaxial Outlet Box

A WELL-DESIGNED television coaxial outlet box (for terminating the incoming aerial feeder) has recently been introduced by Wolsey Television Ltd. of 75, Gresham Road, Brixton, S.W.9. It consists of three parts and is contrived so that the cable can be connected and clamped down without bending and straining the inner conductor. The socket is of standard dimensions, with outer contact surfaces cadmium-plated and inner surfaces silver-plated, and has a polythene dielectric. The strongly made cover is $\frac{1}{2}$in deep, has a bronze-type finish, and is provided with two screw holes for fixing down to woodwork.

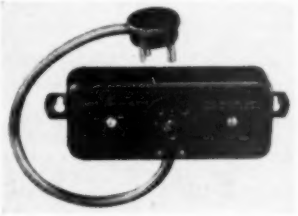
The firm has also introduced a new coaxial plug of simple design which

Component parts of the Wolsey television coaxial outlet box.

can be used with any standard socket and with any cable between 0.165in and 0.24in in diameter. The cable is clamped by sprung claws which are forced into the metal braiding when the outer case of the plug is pushed on.

All-wave Interference Suppressor

A NEW mains interference suppressor produced by E.M.I. is claimed to be equally effective at all frequencies from 150kc/s to 30Mc/s (between 10 and 2,000 metres) and is suitable for use with any radio receiver or electrical appliance operating on 100-250 volts a.c. or d.c. and



E.M.I. mains interference suppressor.

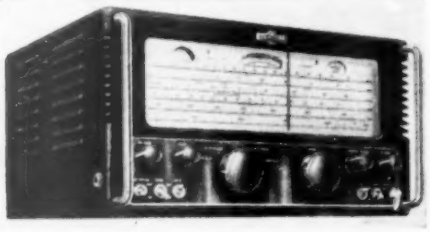
drawing up to 5 amps. It is housed in a moulded case designed to permit simple fixing to a skirting board. A mains plug and socket are fitted for easy connection between the receiver or appliance and the supply point. The suppressor is available from the Dealers' Service Development Division of E.M.I. Sales & Service Ltd., Blyth Road, Hayes, Middlesex, at £2 9s 6d.

Communications Receiver

QUITE a number of improvements have been made to the 15-valve Eddystone 680 communications receiver (reviewed in our September 1949 issue) and in its new guise it is known as the Model 680X. The main change is in the frontal appearance, the small rectangular scale opening now being replaced by one extending right across the cabinet.

A few small changes have been made also in the circuit; for example a small resistor is included in each r.f. grid, presumably for anti-parasitic purposes, although nothing of this nature was met with in the set we tested. There has been a rearrangement of the headphone circuit and the signal is now taken from the anode of the output valve feeding the phase inverter. A capacitance-resistance network is used and the insertion of the headphone plug in its jack automatically disconnects the loudspeaker.

The makers are Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31, and the price is £106.



Eddystone 15-valve communications receiver, Model 680X.

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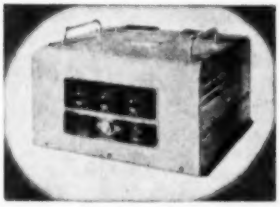

Model T620.

This 20 watt amplifier model T620 can be operated from batteries as well as from AC mains by the addition of a plug-in adaptor unit for 6 volts, thus adding, considerably to the variety of applications for which this amplifier is suitable.

This new model is similar in general design to the well-known 30 watt type T633B, and is fitted with the same controls, push-pull output with negative feed-back, high and low impedance outputs, etc.

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RANDOM RADIATIONS

By "DIALLIST"

We Sink Our Differences: But Our Syncs Differ

APART FROM THE FACT that it uses more scanning lines, there is one rather interesting difference, which you may or may not have noticed, between the French 819-line system and both the United States 525-line and our 405-line systems. This is in the method of frame synchronization. At the end of each frame the B.B.C. transmits a series of eight broad (40 μsec) pulses which collectively form the frame sync signal. In the French 819-line transmissions there is only one 20-μsec frame sync pulse. Under our system a complete image of two interlaced frames is built up in this way: immediately after line 405 of the preceding image come the eight sync pulses, of 40 μsec each, at 10 μsec intervals. Thus the eight pulses and the eight intervals occupy 400 μsec, or the time equivalent of four scanning lines with their sync pulses. Then, after 10 lines of "blacks" and line sync pulses frame No. 1 starts at line 15. It is brought to an end at line 202½ by the next series of frame sync pulses and "blacks" and the second frame starts at line 216½.

The French System

In the 819-line system the duration of a line plus the 2.5-μsec line sync pulse is approximately 50 μsec. Immediately after line 819 of the preceding image come 3½ lines of "blacks," then the 20-μsec frame pulse followed by 37 lines of blacks. Frame No. 1 starts at line 42 and ends at line 409½. After a similar 41-line series of "blacks" containing a single frame sync pulse, frame No. 2 starts at line 450½. The line sync pulses are, of course, kept going during each inter-frame blackout. After disentangling the circuit diagram of an 819-line receiver, I gather that this system makes it rather more difficult than does ours to obtain effective synchronization at the receiving end. Even the line sync pulses are passed through an amplifier before being applied to the line oscillator.

The Resistor Problem

ONE OR TWO READERS seem to have misunderstood the nature of my grouse about fixed resistors. "Surely," writes one of them, a South African doctor, "nobody would think of putting such a component into a piece of electronic apparatus without first verifying its value." I agree. But I was not complaining of any failure on the part of new resistors to show their marked values within the tolerance limits of their classes. What was—and still is—biting me is this kind of thing. In a particular circuit you need a resistor of round about 20,000 ohms. You pick one of adequate power rating, allowing what should be an ample factor of safety. Its actual value turns out to be, say, 21,500 ohms both before and after you solder it into place. Sometime later faulty working develops and the cause is eventually traced to that resistor, which now shows an enormously different value. Greater reliability in resistors would, I am convinced, mean far less trouble in radio, television and other electronic gear.

Queer Goings On

WRITING FROM A VILLAGE a little south of Okehampton in Devon, a puzzled correspondent reports that ever since the B.B.C.'s temporary caravan transmitter got to work near Barnstaple in early March, he has suffered from severe *daylight* fading. Previously he had enjoyed a satisfactory service from Start Point, though one would imagine that the field strength of this station cannot be very great in his part of the world, which lies right in the wireless shadow of the 1,800-ft Cawsand Beacon. The village is almost on a straight line joining Start Point and Fremington, where the 250-watt temporary station is working. The two ground-wave signals must be interacting somehow—possibly owing to reflections of one or both from one of the Tors. Have other mid-Devon readers had similar experiences? Is it some kind of ground-wave variety of the Luxembourg effect?

A Ticklish Job

NEEDING A MIDGET a.f. transformer for a gadget that I was engaged in making, I looked through the bits and pieces drawer to see if it could provide anything suitable. Yes; there was the very thing I wanted. But my joy was short-lived; for, though the primary passed its tests with full marks, the secondary was "dis." The protective paper covering was carefully removed, disclosing an outer layer consisting of what looked like about a million turns of cobweb-fine enamelled wire. I was just going to drop the thing into the wastepaper basket, so hopeless seemed the idea of locating—to say nothing of mending—the break, when something

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prompted me to take a look at it with a strong magnifying glass. My luck was in, for I found two little "whiskers" sticking out near the middle of the layer. It might not, of course, be the only break; still, a repair was worth trying.

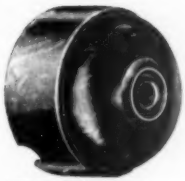
Something Attempted

With the help of a pair of tweezers, one end was gently coaxed until about ¾in of it was free. Then, the other end was similarly treated until a whole turn of it had been unwound. This latter having been cut to a suitable length, the two ends were bared by the careful use of rouge paper and twisted together, a strip of waxed paper being placed under the joint. To my no small joy, the secondary now proved to be continuous. The joint was successfully soldered with the aid of the new 5-cored Multicore and a miniature iron. Finally, everything was made shipshape and secure by winding on a layer of insulating tape.

Telephone and Wireless Set

YOU MAY REMEMBER the queer instances I described recently of the interaction which has on occasions taken place between my telephone and the domestic broadcast receiver. In case you don't, what happens is that very occasionally when someone is using the telephone, which is in another room, the conversation is clearly and fairly strongly reproduced by the loudspeaker of the set. An engineer, who was many years ago in the department of the G.P.O. which deals with complaints of interference, tells me that he has known many such cases. The cause is invariably the presence of a non-linear resistance in some part of the telephone circuit. The microphone itself might be responsible, but I believe that a special capacitor is now fitted to prevent this. The most probable culprit is a bad joint—or rather an imperfect joint, which just once in a way becomes bad owing to the effects of weather, temperature or vibration. The rectified telephone signal is usually passed to the wireless set either by re-radiation from the telephone wires and pickup by the radio aerial, or *via* a common impedance in the telephone and wireless earth connections. I am glad to have this explanation, for the phenomenon is so rare and so transient in my own house that I have never been able to investigate it properly. The long-suffering G.P.O. engineers would have to take up residence to be sure of hearing a repeat performance!

JUST PLUG IN



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Divorce Wanted

THE modern domestic wireless set is such a reliable and trouble-free instrument that I have long since given up "rolling my own" except for experimental and other special purposes. But whenever I buy a new set I always resent having to pay for something which I don't want and never use. I refer, of course, to the loudspeaker, which is built into the set.

I have no quarrel with such an instrument *per se*. It is usually of excellent design and sometimes of peerless performance, but I dislike it churning out Chopin close against my ear and I think that designers should arrange a divorce between set and loudspeaker. I could, of course, solve the problem by putting the set at the far side of the room but I should then run the risk of tripping over the cat every time I desired to change from Charlie Chester to Chamber music. If you look at the position of the wireless receiver in the average home it is usually where mine is, namely, by the fireside where I can get at the controls comfortably from my armchair.

The remedy I adopted long ago was to buy a good extension loudspeaker and place it at the other side of the room, and I think that if more people realized how much this improved the pleasure of listening they would do likewise. But having done it they would probably curse me soundly and accuse me of getting a handsome rake-off from the extension loudspeaker manufacturers, for it cannot be denied that the noxious noises belched forth by many extension loudspeakers to-day is a travesty of what the inbuilt loudspeaker gives.

The reason is that too often we find a first-class set harnessed to an equally first-class extension loudspeaker and forming as ill-matched a pair as sometimes appears before the local vicar to be united in what A. P. Herbert has called "holy deadlock." In the case of an incompatible set and loudspeaker, it is, of course, ill-matched ohms that form the "cause, or just impediment," and the remedy is aptly summed up in the phrase *caveat emptor*. I am no Agag and will not, therefore, venture to give any opinion on the cause and cure of matrimonial mismatching.

Am I a Pirate?

THE P.M.G. has for a long time been making a praiseworthy effort to call wireless pirates to repentance by a high-pressure display of posters. It is quite obvious, however, that new blood has been injected into this anti-pirate campaign as we have had quite a crop of novel and ingenious posters recently. They are not designed to strike terror into the hearts of the timid nor to appeal to the hardened male-factor but to give information to the genuinely, if stupidly, ignorant.

Broadcasting has been with us for so long that everybody must be aware that a licence for a broadcast receiver is necessary, but the fact that television and car radios are not covered by the ordinary licence

has not been publicized nearly enough. Therefore, I welcome the poster which tells me that there are three types of licence, namely, a sound-only licence for £1, a television licence for £2, which also covers sound, and a car-radio sound licence for £1.

While reading this the other day, with all the soul-satisfying smugness of self-righteousness, I was suddenly assailed by a horrible doubt as to whether I was, after all, numbered among the goats and not the sheep, for installed in my car—"within the meaning of the act"—I have a television set. I installed this and a telescopic aerial for use when I desire to view some important event which is being televised when I am away from home.

Frankly, I do not think I am within the law. As an ordinary sound-only licence does not cover car-radio it is logical to suppose that my ordinary domestic television licence does not cover my car television. It is also certain my £1 car-radio licence does not cover car television; the poster makes it quite clear that it is for sound only.

Although there appears to be no

are You a Pirate?
look or listen
at other people's expense
A LICENCE FOR A YEAR COSTS
£1 FOR A SOUND SET . . .
£2 FOR TELEVISION & SOUND . .
£1 FOR A SOUND SET FITTED IN A CAR

licence obtainable to put me on the right side of the law, my conscience will not let me sleep well o'nights until I get this point settled.

The Telepædicator

OF the many adjuncts to the wireless set, such as pickups and playing desks which have appeared during the last quarter of a century, there is one which is still in use but has never shown any dramatic technical improvement since it first appeared over twenty years ago.

I mean the baby-alarm which consists of a microphone placed over a child's cot and connected to the receiver downstairs in such a manner that when the baby bawls for nourishment, clean pyjamas, or just out of pure cussedness, its caterwaulings are superimposed on the radio programme.

This telepædicator, as I feel sure the Yanks must call it, was first described in the Readers' Problems section of *W.W.* in the knob-twiddling twenties and was very little different from the one I saw at a recent National exhibition at Olympia. There was little difference between it and the original. I ventured to point out to one of the sylphlike sirens on the stand that there had been but little change in design in twenty years or more, but far from being disconcerted she somewhat tartly, but very rightly, pointed out that there had been little change in the design of babies over this period. It is many years since I visited Queen Charlotte's Natarium but I suppose the 1952 models coming off its assembly lines are indistinguishable from the old 1927 models.

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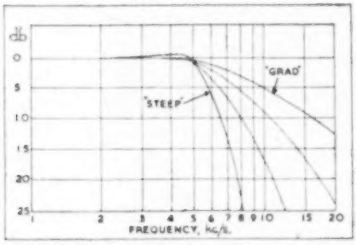
NO INDUCTORS ("CHOKES") ARE USED, and all their disadvantages are completely eliminated. The turnover frequencies are 5 kc/s, 7 kc/s, and 9 kc/s and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.



Frequency/amplitude curves for the "TREBLE—3" position (5 kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7 kc/s and 9 kc/s ("—2" and "—1" positions).

The filters consist essentially of twin-T resistor-capacitor networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include :—

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(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control altering the terminating impedance and the insertion loss.)

(d) There are no chokes to cause magnetic hum pick-up.

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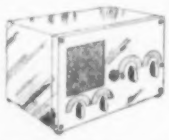


With the Teletracer, signals can be followed through the T.V. to the tube or loudspeaker. Similarly powerful indications can be obtained in and around the sync. separator and time base sections. The Teletracer uses 5 valves and speaker and operates entirely from A.C. or D.C. mains. Send immediately for your free copy of the instruction manual or better still save time by sending £6 10 - plus 7/6 post and insurance for the complete outfit.

SUB-MINIATURE COMPONENTS

Highly suitable for deaf aids, flying control, or other midget electronic equipment. All ex-unused equipment.

Sub-Miniature Valves—Wire Ended

Type	Approx. size	Fil. Volt	Heater Current	Suitability	Price
CV385	8 mm. dia. 36 mm. long	1.4 v.	25 mA	Output Pentode	5/9
CV387	9 mm. dia., 36 mm. long	1.4 v.	25mA	Output Pentode	5/9
CV2107	8 mm. wide, 29 mm. long	0.75 v.	25 mA	HF/AF Pentode	4/9
CV443	9 mm. dia., 29 mm. long	0.75 v.	25 mA	HF/AF Pentode	4/9
CV386	9 mm. dia., 28 mm. long	0.75 v.	25 mA	HF/AF Pentode	4/9

Sub-Miniature Volume Controls
Type 1. 3 meg with switch probably the smallest control made, can be used with finger plate removed (control being effected by an 8 B.A. screw). Diameter without finger plate ¼in., with finger plate ½in. Price 3/9 each.
Type 2. Again 3 meg with switch, this one is same size but cannot be used without the finger plate. Price 3/3.

Output Matching Transformers
Ratio approximately 10 to 1 intended to match output of CV385 or CV387 into Crystal earpiece. Price 3/6.

Crystal Earpiece
Highly sensitive, very light weight complete with 1 yard of special P.V.C. covered tinsel flex and slide contacts. Price 8/6.
Ditto, but without flex or contact slide—note this makes excellent microphone. Price 6/6.

Crystal Microphone
Diaphragm driven, extremely sensitive, made for deaf aid but highly suitable for recorder work, 7/9 each, or with bakelite case, 14/6.

Hearing Aid Case
Bakelite with lapel clip. Also makes an excellent case for the above crystal microphone, which would be equal to those being advertised at 4/5 gns. Price 7/9.

4-Core P.V.C. Covered Tinsel Flex Leads
Suitable for L.T. and H.T.—length approximately 1 yard. Price 1/3, or complete with L.T. and H.T. battery plug, 3/9.

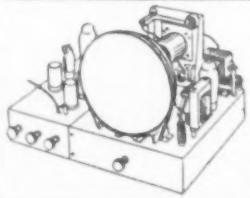
Battery Plugs
For hearing aid battery. L.T. 2 pin price 1/6. H.T. 3 pin. Price 1/6 each.

WIRE WELDER

Bakelite covered wire welder for rapidly joining copper or alloy wires of between 28 and 48 S.W.G. First pressure of the trigger brings two anvils together to hold the wires, second pressure closes the switch and fuses the wires. Cleaning is not necessary and the process requires no fusing agent.

Step down transformer or other low voltage source is required but a resistance in the handle limits the maximum current. Special Price, only 9/6 each.

TECHNICAL AID & 14 DAYS' APPROVAL



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You can have this data on 14 days' approval, in other words, if after studying it you doubt your ability to make the Televisor simply return the data and we will refund your cash, less only 6d. for postage and packing.

TRANSFORMER BARGAINS

All by famous makers

250 mA, 350-0-350 v., 6.3 v. at 6 amps, 5 v. at 3 amps, 4 v. at 5 amps. Price 37/6.
120 mA, 350-0-350 v., 4 v. at 4 amps C.T., 4 v. at 2 amps C.T. Price 42/6.
100 mA, 350-0-350 v., 6.3 v. at 4 amps, 5 v. at 3 amps, fully shrouded upright mounting. Price 22/6.
100 mA, 250-0-250 v., 6.3 v. at 6 amps, 5 v. at 3 amps, fully shrouded upright mounting. Price 27/6.
85 mA, 350-0-350 v., 4 v. at 2.5 amps C.T., 4 v. at 5 amps C.T. Price 37/-.
80 mA, 350-0-350 v., 0-4-6.3 v. at 5 amps, 0-4-5 v. at 2 amps. Price 19/6.
80 mA, 300-0-300 v., 6.3 v. at 4 amps C.T., 5 v. at 2 amps upright mounting. Price 19/6.
80 mA, 300-0-300 v., 6.3 v. at 6 amps, 4 v. at 2 amps half shrouded. Price 18/6.
80 mA, 300-0-300 v., 4 v. at 6 amps, 4 v. at 2 amps, half shrouded. Price 18/6.
80 mA, 280-0-280 v., 4 v. at 1.5 amps, 4 v. at 6 amps, half shrouded. Price 18/6.

70 mA, 235-0-235 v., 6.3 v. at 2.5 amps, 5 v. at 2 amps, upright mounting, price 22/6.
70 mA, 235-0-235 v., 4 v. at 4 amps, 4 v. at 1 amp, upright mounting. Price 22/6.
60 mA, 260-0-260 v., 6.3 v. at 3 amps, 5 v. at 2 amps, half shrouded. Price 16/6.
60 mA, 260-0-260 v., 4 v. at 4 amps, 4 v. at 2 amps, half shrouded. Price 16/6.
60 mA, 260-0-260 v., 4 v. at 3 amps, 4 v. at 2 amps, upright mounting, fully shrouded. Price 18/6.
40 mA, 325-0-325 v., 6.3 v. at 3 amps, upright mounting. Price 15/6.

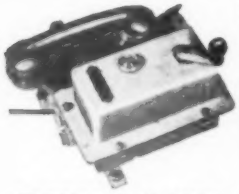
T.V. TRANSFORMERS

Fixed Primary—H.T. Secondary, 300-0-300 v. at 150 mA, L.T. 7.5-0-7.5 v. at 3 amps and 4 v. at 3 amps. Dimensions are 4¼in. high × 4in. × 3¼in. Price 17/6, plus 2/- postage and packing.

Good stocks of filament and auto-transformers.

WELDING TRANSFORMERS

12 v. 50 amp. output from 200-240 v. A.C. mains.
Primary and secondary separated by a special screen to prevent interference, this screen is brought out to the terminal block. Complete in metal case with carrying handle, price £4 5/-, plus 5/- carriage and packing.



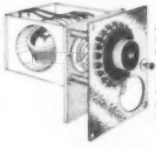
EX-ROYAL NAVY SOUND POWERED TELEPHONE

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several 'phones are used together will indicate which one is being called. Size 7¼in. × 9in. × 7¼in., wall mounting, designed for ships' use, but equally suitable for home, office, warehouse, factory, garage, etc. Price 37/6 each, plus 3/6 carriage.

REMOTE CONTROL

With only one pair of wires and a simple push button you can select any one of four stations without leaving your armchair. This is just one of the many applications of our impulse relay. There are many other purposes to which it can be put. We will supply a booklet of circuits for 1/- post free. The price for the last remaining stocks of these relays is 2/6 each. Note thay are somewhat soiled, due to storage but mechanically O.K.

VARIOMETER ASSEMBLY



As illustrated this is useful for experimental circuits, crystal sets, etc. Price 3/9 each.

PYREX AERIAL INSULATORS

Ideal for aerial connections through cabin walls or through panels. Consists of glass dome with threaded rod and terminal ends and metal fixing flange. Price 2/- each.

FREE GIFT

With every order for a Germanium Diode we give free a blueprint showing full constructional details of our "*Handyman Crystal Receiver.*"

WHAT'S WRONG ? WIN £5

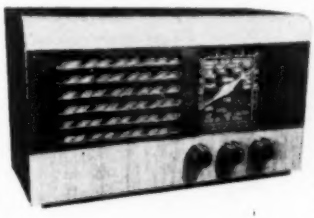
You are fault finding on a "dead" receiver of pre-war vintage and you receive a shock from the metalising of the DDT valve whilst touching the chassis. What fault is indicated ?
Prizes of £5, £3 and £2 will be sent to the first three correct answers opened.
Notes.—1. The correct answer and the names of the winners will be sent to all entrants.
2. Entries must be in by first post on June 30th.
3. Entry should be on a separate sheet.

YOURS FOR £4. 17. 6d
COMMUNICATIONS RECEIVER R.1155

We have just bought a new consignment of these and can guarantee them to be absolutely unused (not just in re-crackled case). This set as most will know is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F. so obviously a robust receiver which will give years of service. The price is **£14 10/-** or will be sent against deposit of **£4 17 6** and balance over 12 months. If you cannot call to collect please include an additional 10/- to cover cost of transit and carriage. This is partly returnable to you if and when you return the transit case.

MAINS POWER PACK FOR R.1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price **£5/10/-** complete with 8in. speaker ready to work, carriage 3/6.



SPECIAL SNIP FOR CONSTRUCTORS

Beautifully made wooden cabinet, complete with punched metal chassis, glass dial with metal supports and clips. 3 knobs and wooden back.
Why not build a few receivers during the summer months, we can supply all the parts for either superhet or T.R.F.?
Price of parcel as above, **29/6**, plus 2/6 postage and insurance.

IDEAL HOLIDAY RECEIVER

The Elpreq "Wolsey" 5 valve A.C./D.C. superhet has a built-in aerial and is of convenient size and weight to take with you on your holiday. Powerful reception on long, medium and short waves—handsome wooden cabinet—illuminated glass dial, with station names—A.V.C. and usual refinements. Size 11in. × 5¼in. × 7in. with B.V.A. valves, 12 months' guarantee. Limited quantity only. **£9 5/-** or **£3 2 6** deposit and balance over 10 months, carriage and insurance, 5/-.

Orders by post are dealt with by our Ruislip depot. To avoid delay address to: E.P.E. Ltd., Dept. 2, Windmill Hill, Ruislip, Middx.

FLUORESCENT LIGHTING UNITS

40-watt Type. This is a combined condenser and choke unit for controlling fluorescent tubes. The only other item needed is a starter switch which can be an automatic type or an ordinary on/off manually operated type. We offer these well made units at less than half price, namely **19/6** each.

80-watt Type. This consists of choke and starting condenser both by G.E.C. again only item required is starter switch. Slightly soiled but perfect, **16/-** complete.

PHOTOCELL RCA 923

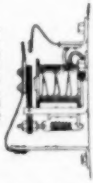
Gas filled tube highly suitable for talkie film equipment, colour matching, safety devices, burglar alarms, door opening, etc., etc. Working voltage 90 v. sensitivity 135 micro amps per lumen. Price **29/6**, limited quantity.

CROCODILE CLIPS

Small instrument, **6d.** Large Car Battery type, **9d.**

CONTACTOR

For breaking 25 amps, coil voltage is 24 v. D.C., but with a re-wind or a small rectifier these will close off A.C. mains. Very heavy duty solid silver contacts. Price **3/6.**



RELAYS

Totally enclosed in bakelite, this relay has a 24 v. coil but can of course be re-wound for mains operation. Its contacts are suitable for breaking 20 amps. Price **4/6, 48/-** doz.

SHEET PAXOLIN

Invaluable for when you are experimenting. Size 6in. × 6in., **1/-.** Size 12in. × 8in., **2/-.** Size 12in. × 12in., **3/6.** Size 24in. × 12in., **6/-.**

NEW CONSTRUCTOR'S BOOK

"*The All Dry Three*" shows how to make an efficient personal set for 70/-. Price **1/6.**

Except for heavy and delicate items where carriage charge is specified, orders over £2 are post free. Under £2 add reasonable amount, bearing in mind a 15lb. parcel costs 2/-. Postable items can be sent C.O.D., additional charge 2/6. List 6d.
Early closing days-Wednesday Ruislip, Saturday City.

ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780
152-153 FLEET STREET, E.C.4. Phone: CENTRAL 2833

ELPREQ PAGES

10,000 VALVES AT PRE-BUDGET PRICES

Below is a list of B.V.A. and Other Proprietory Valves which we supply at the pre-1951 Budget price i.e. only one third Tax.

We can of course supply most of the other types to complete the range but most not listed would have to be supplied at the current rate of Tax i.e. 66 .

We can give a very prompt insured C.O.D. service on valves and we shall be happy to execute your orders.

TYPES

6Z4	6C8	12BSGT	75A	2151	DF92	EZ2	KT243	Pen3520	SP2220	
6180TM	6C7	12J5GT	76	220IPT	DH2	EZ40	KW32	PJ10	SQT4	
1A4E	6C8G	12J7GT	77	6153T	DH24	EZ41	K23B	PL33	SS210	
1A40	6C9	12K36T	78	8355A	DH63	E220B	K30G	PL38	SU25	
1A5GT	6C10	12SA7	80	9004	DH73	FC2	K36K	PL38N	SU61	
1A5GT G	6D1	12Q7	82	13201A	DH76	FC4	K33A	PL82	SU2150A	U71
1A4E	6D2	12SF5	83	11726GT G	DH77	FC13	K33B	PM2A	SW1	U74
1A40	6D4	12SJ7	84	ACDD	DH147	FC13C	K40S	PM2B	S3DD	U76
1A5GT	6D6	12SK7	89	AC HPP	DH150	FC141	K50S	PM2HL	S4A	U78
1A5GT G	6E5	12SQ7	101	ACHIM	DK91	FT104	K52	PM3	S4V	U82
1A6	6F1	12SR7	104V	ACME	DL	F5R	K70B	PM12	S8	U142
1A6E	6F5GT	13SA	105G6	ACP	DL35	G6J2	K70D	PM12M	S23	U145
1B4	6F5GT	13VPA	110	ACPNDH	DL310	GU1	K80A	PM12MM	S27	U251
1B4E	6F6	15	112A	ACPT PEN	DL32	GU50	K143	PM14	S130	U404
1B5 258	6F7	15A2	117Z6	ACP1	DL34M	G4120	K183	PM20	S215VM	U914
1BC1	6F7E	15D1	120	ACP4	DL35	HD13	K404	PM22	S217	U931
1B42	6F8	15D2	124	ACTH4	DL65	HD14	LB210	PM22D	S410	U939
1B122	6F13	15E	150A	AC TP	DL74M	HD24	LD2	PM24A	S410N	VMP4G
1C1	6F15	18	150B	AC TZ	DL82	HFP13	LD210	PM24M	S435N	VM4K
1C6	6F16	19	154V	AC VH	DL92	HL2	LD210	PM25	S1328	VQ8
1C6	6G5	20C	164V	ACVP1	DL92	HLA2	LG210	PM26C	TBC14	VQ13
1C7G	6G6G	20D1	185BT	AC2 HL	DL93	HL DD1320	LL4	PM26D	TBL14	VQ13S
1D5G	6G6G	20D2	202DDT	AC2PEN	DL94	HL2	LP2	PPL4	TB144	VP2BT
1D6	6H6G	20F2	202MPG	AC2PENDO	DL145	HL4G	LP220	PP2	TB102	VP2B
1D7G	6H7G	21A	202STH	AL60	DL74M	HL13	L1	PP3/250	TB122	VP2D
1EW4A	6H6G	22KV41	202VP	APP4A	DN41	HL13C	L2	PP3/425	TB822	VP4
1F3	6J5G	24	202VPB	APP4B	DN143	HL21	L2DD	PP5/400	TB5013	VP4C
1F3	6J7G	24A	203THA	APP4C	DT215	HL21DD	L13	PP6B	TB9920	VP13
1F5G	6J8G	24E	210DDT	APP4E	DV8G	HL23	L21DD	PP8C	TCH24	VP13A
1F6	6K8G	24G	210DG	APP6E	DW30	HL33DD	L63	PP6E	TDD2A	VP13B
1F7GH	6K8G	25S5	210HL	AP141	D020	HL41	L77	PP13A	TDD4	VP13C
1G4G	6K8GT	25L5	210RC	ARP4	D024	HL41DD	L410	PP24	TDD13	VP13K
1G5G	6K7GT	25Y5	210VPT	ASL125	D026	HL42DD	ME2	PP24S	TDD13C	VP13X
1M4G	6K8	25Z5	215P	AZ1	D1	HL45DD	ME920	PP34	TDD25	VP14
1N5G	6L5G	26	215SG	A4E	D3	HL73C	MHD4	PP225	TE5G4	VP20
1J6	6L5	27	220B	A11C	D15	HL133	MHL4	PP411C	TF44	VP23
1LA4	6L6G	28D7	220HPT	A20B	D41	HL133DD	MHL13	PP411S	TH4	VP28
1LA4E	6L7G	30	220IPT	A36A	D42	HL210	MH4	PT DD35DA	TH4A	VP41
1LA6	6L18	31	220P	A36C	D43	HL1320	MH41	PT10	TH13C	VP41E
1LH4	6L19	32E	220PA	A50A	D63	HPB 13	MH206	PT24A	TH21C	VP60
1LN5	6N6GT	33	220PT	BLL32	D77	HP13	MH4103	PT24DAL	TH29DA	VP133
1N5GT	6N7	34	220TH	BL63	D92	HP210	MH4105	PT230	TH30	VP210
1P10	6P5GT	35	220VPB	BR202	D400	HP211C	MH4106	PV29	TH30C	VP210D
1P11	6Q7GT	35A5	220VS	BTHNG	D418	HP215	MKT4	PV4005	TH?33	VP1320
1Q5GT	6R7GT	35Z3	220VSG	BVA42	D3597A	HP2118	ML4	PX230	TH2321	VP1322
1RF120	6S7	35Z4	222JH	BVA43	EAB1	HP4101	ML6	PZ230SW	TM1	VR1C
1R5	6SA7G	35Z5GT	225DU	BVA44	EA50	HP4101C	MP PEN	PY30	T 914	VR43
1S4	6SF7	36	230PEN	BVA45	EAF42	HP4106	MR1	PY31	TP22	V312
1T4	6SG7	36E	230XP	BVA47	EBC3	HP4106C	MS PEN	PY82	TP23	V872
1T5GT	6SH7	37	240QP	BVA48	EBC33	HP4106G	MS PENB	P2	TP25	V914
1V	6SJ7	38	244V	BVA86	EBC41	HP4108	MSP4	P41	TP26	V1902
2	6SK7	39E	250L4	B2	EBF2	HP4115	MSP41	P61	TP220	V5116
2A3	6SL7	39	301	B21	EBF11	HR2	MS4	P140N	TP230	VW48
2A6	6SN7	41	302THA	B30	EBF80	HR2S	MS4B	P215	TP2620	WD40
2A7	6SQ7	41E	303	CBL1	EBL1	HR210	MU12	P220	TSE4	WD142
2A8	6SS7	41MDG	304	CBL31	EBL21	HVU1	MU4105	P220A	TSP4	W17
2D4A	6S 6G	41MH	307A	C14	EB4	HW20L	MV8PEN	P425	TT4	W21
2D13	6T7G	41MHL	329	CL33	EB34	H2	MVSPENY	P430	TT4A	W65
2D13C	6U5G	41MLF	340	CP220	EB41	H2MB	MX40	P610	TX4	W76
2D17	6U7	41MP	354V	CR84	ECC31	H4D	NHL 13	QP21	T421	W77
2P	6U7S	41MPG	402QT	C1C	ECC91	H13	NHL13L	QP22A	T2	W81M
2YR215	6V6	41MPT	402PEN	C2	ECH11	H30	NH4105	QP22B	T2C	W142
2X2	6V7	41MSG	410HF	C5B	ECH21	H30	N14	QP25	T31	W143
3Z3	6W5G	41MTA	410PT	C9	ECH42	H42	N16	QP42	T32	W145
3A4	6W7	41MTL	415PG	C10	ECL80	H63	N37	QP230	T41	X7
3Q5	6X4	41MTS	415XP	C10D	EC5	H141D	N43	RB41	UBC41	X14
3Q5GT	6Y4	41MXP	423PT	C20C	EC31	IRV120/3505	N77	RB120	UBF80	X17
3V4	6ZY5	41STH	425P	C23B	EC53	J240	N78	RC250/1000	UB41	X22
3Y4	8Z5	42	425XP	C30B	EC91	KBC32	N145	RF120	UCH21	X24
4D1	7A8	42A	484V	C36A	EC52	KCP30	N147	RK34	UCH42	X41C
4THA	7A8	42E	523	C36C	EF5	KK32	OC13L	RW12P2000	UD41	X61M
4TPB	7A7E	42MP PEN	667G	C50N	EF6	KL4	OD3	RX210	UFW29L	X63
4TSP	7B5	42MPT	6466	DAC1	EF8	KL32	OM4	R8	UF41	X64
4X1P	7B7	42PTB	696	DAC32	EF9	KL35	OM6	SD2	UF42	X65
4.100 BU	7C5	43	717A	DC P	EF13	KTW61	OM9	SD4	UBL41	X71M
5U4G	7C6	45LU	802	DC SG	EF22	KTW61M	O202	SD6	UAF41	X78
5X4G	7C7	44E	807	DC 25G	EF36	KTW63	PA1	SD20	UL44	X78M
5Y3G	7D3	45DU	904V	DC 25GVM	EF37A	KTW73	PA20	SE211	UL46	X79
5Y3S	7D5	45Z5	954	DC HLE	EF39	KTZ2	PD220	SE211C	UM4	X79M
5Y4	7D6	46	955	DDA13	EF41	KTZ41	PD220A	SG220	UR3	X7S
5Z3	7H7	47	994V	DD14	EF50	KTZ63	PD3521	SG220SW	UR3C	X79
5AC7	7Q7	48	12150T	DD PEN	EF55	KT4	PENA4	SG410	UR13	X81M
5AE3	7S7	49A	1506	DDTR13	EF80	KT8	PENB4	SH74A	UU3	X154
5AE8	7Y4	50L8	1619	DDT2	EF91	KT24	PENDD 1360	SP2	UU7	X145
5AG7	8A1	50Y6	1632	DDT4	EF92	KT31	PENDD 2520	SP2B	UU9	X146
5AL5	8D2	55	1642	DDT16	EH2	KT32	PENDD 4020	SP2D	UU30/250	X150
5AM8	9D2	56	1701	DD4	EK3	KT33C	PEN4DD	SP4	UU41	X410
6A3	10C1	57	1801	DD4D	EK3	KT35	Pen22	SP4B	UU60/250	Y13
6A8	10D1	58	1821	DD13	EL2	KT41	Pen24	SP13	UX8	Y63
6A7	10D2	59	1904	DDL4	EL3	KT42	Pen25	SP13C	UY21	Y220
6BA8	10F1	61BT	1912	DD40	EL32	KT44	Pen36C	SP13S	UY41	ZD
6BE6	10F3	61SPT	1913	DD41	EL33	KT45	Pen40DD	SP20	U4	ZD2
6B4G	10F9	92BT	1920	DD101	EL35	KT61	Pen45	SP22	U12	Z14
6B8	10LD11	92DDT	1927	DD207	EL38	KT63	Pen45DD	SP41	U16	ZD17
6B7	10P13	93TH	1928	DD620	EL41	KT66	Pen46	SP42	U17	Z21
6B7G	10P14	93VP	1934	DD2520	EL42	KT71	Pen220	SP42P	U21	Z22
6B7M	11D3	96KU	2050	DEH610	EL82	KT72	Pen220a	SP61	U24	Z26
6B8	11D6	97PT	2060	DET19	EL91	KT74	Pen231	SP210	U25	Z62
6B8G	12A3	70A7T	2101	DE3	EM4	KT76	Pen383	SP215	U31	Z63
6C5	12A6	71A	2102	DF91	EY91	KT81	Pen425	SP220	U35	Z66
6C5GT	12AT7	78	2103	DF91	EY91	KT220	Pen425DD	SP1320	U37	Z77

ENAMELLED WIRE
(On wooden reels).

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	2/-
20	1/4	2/2
22	1/5	2/4
24	1/6	2/6
26	1/7	2/8
27	1/8	2/9
28	1/8	2/10
30	1/9	3/-
31	1/10	3/1
32	1/10	3/2
33	1/11	3/3
34	1/11	3/4
36	2/-	3/6
38	2/2	3/10
40	2/4	4/2

TINNED COPPER WIRE

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/5	2/-
20	1/4	2/2
22	1/5	2/5

DOUBLE SILK COVERED WIRE.

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	1/11
19	1/5	2/3
20	1/6	2/6
22	1/8	2/10
23	1/9	3/-
24	1/9	3/-
26	1/11	3/4
27	2/-	3/6
28	2/1	3/8
29	2/2	3/10
30	2/3	4/-
31	2/4	4/2
32	2/6	4/6
33	2/9	5/-
34	2/10	5/2
35	3/-	5/6
36	3/2	5/10
38	3/6	6/6
39	3/9	—
40	4/-	7/6
41	2/3	—
42	2/6	—

INDICATOR LAMP

This is fitted with a clear Perspex top, it is therefore highly suitable as an indicator lamp or for illuminating inside a radiogram or similar cabinet or even as a map reading light in a car. Takes standard screw-in flash light bulb. Price 1/6 complete.

PYE PLUG AND SOCKET
6d. each part.

SPECIAL PERSONAL SET OFFER

Resulting from the changeover of a famous manufacturer to important work, we are able to offer practically all the parts for this really neat personal radio illustrated.

The most important thing of course is the cabinet, and for this we can offer a complete kit of parts, which includes cream plastic lid, base and escutcheon, crackled metal body and all accessories such as knobs, hinges, lid arm, and clips etc. Price 22/6. Cabinet size, 7in. × 4in. × 3¼in. Other items available are: **Metal Chassis.** Five part assembly comprises the main chassis and sections for holding the batteries and the loudspeaker. Price 4/6. Ditto with four B7G valve holders already riveted in their correct positions. Price 7/-.

Frame Aerial Cover 1/6

Frame Aerial 3/6

Oscillator Coil 3/6

I.F. Transformers, Wearite Midget Type 400B 15/- each

Volume Control 1 meg. Midget 3/6

Speaker Midget Plessey 3in. 14/6

Output Transformer to match 6/-

NOTE.—All these parts are offered separately. Valves required are 1R5, 1S5, 1T4, 3S5 or 3V4, all available at low prices, send for our current valve list.

Resistors Miscellaneous Total 11 4/-

Condensers Miscellaneous Total 10 4/6

B7G Amphenol Valve Holders 8d. each

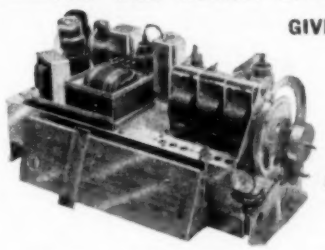
Assembly instructions, including wiring diagram and alignment data 2/6

Battery Stud Connectors, per pair 9d.

Tuning Condenser 8/6

On Off Switch. lid operated 1/6

FOR ONE MONTH ONLY



GIVE AWAY PRICE

only £6. 19. 6

7 VALVE, 5 WAVE-BAND RADIO CHASSIS

A famous set by a famous manufacturer. Undoubtedly a serious listener's receiver. Among many special features are a H.F. stage and tuning indicator. Tunes up to 11-metre band.

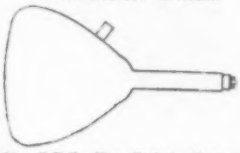
We have a few left, less valves and power packs, otherwise in good condition, they definitely have never been used. While stocks last and for this month only you can have one at £6 19 6, plus carriage and packing 15/-. **H.P. Terms** £2 6 6 deposit and nine monthly payments of 12/-.

BLANK CHASSIS
18 S.W.G. Aluminium

7 x 3½ x 2	5/-	16 x 10 x 3	8/3
9½ x 4½ x 2½	5/9	16 x 8 x 3	8/-
10 x 8 x 2½	7/-	11½ x 10 x 3	7/6
10 x 5½ x 2½	6/6	16 x 12 x 3	8/8
10 x 9 x 3	7/3	19½ x 9 x 2½	8/3
12 x 9 x 2½	7/3	20 x 10 x 3	10/-
14 x 9 x 2½	7/6	21½ x 9⅛ x 2½	10/6
14 x 10 x 3	8/-		

Orders by post are dealt with by our Ruislip depot. To avoid delay address to Electronic Precision Equipment, Ltd., Dept. 7, Windmill Hill, Ruislip, Middlesex.

MAGNETIC T.V TUBES.



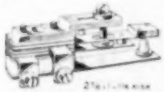
9in. G.E.C. Flat Ended, Heater 6.3 v. From 55/-

These tubes have had very little use and will probably give years of service.

TYPE 2. Have small ion burns otherwise in good condition. Price £3 15/- each.

TYPE 3. Have large ion burns but are useful as spare or when first testing out a circuit, or doing repairs etc. Price £2 15/- each.

NOTE: We guarantee a 'working' tube. If not calling please add 7/6 each tube for packing and postage.



5 AMP ADJUSTABLE THERMOSTAT

Useful for the control of appliances such as convectors, gluepots, Vulcanisers, hot plates etc. This thermostat has a temperature range of between 50-550 deg. F. and is fitted with heavy 15 amp. A.C. silver contacts and a patented arc damping device. Price 14/6. 1 Amp Model 3/6.

IMPULSE MOTOR

With drive mechanism to which two additional switches have been coupled. Mounted in totally screened box measuring 8¼ × 3¼ × 6¼in. Price 25/- each.

FLEXIBLE COUPLINGS

There are sometimes known as bellows couplings because they will extend as well as bend. They are ideal for joining shafts which are out of alignment and for slug tuning controls where the core has to come in and out. Price 1/9 each.

TWO-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15 amp.-hour size approx. 6in. × 1¼in. square in ebonite case, pre-charged, only need filling with acid, 5/9 each, plus 1/3 post and insurance. Six or more post free.

Except for heavy and delicate items where carriage charge is specified, orders of over £2 are post free. Under £2 add reasonable amount, bearing in mind a 15lb. parcel cost 2/-. Postable items can be sent C.O.D. additional charge 2/6. List 6d.

EARLY CLOSING DAYS WEDNESDAY, RUISLIP — SATURDAY, CITY.

ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780

152-153 FLEET STREET, E.C.4. Phone: CENTRAL 2833

LASKY'S RADIO
"World Renowned for Service & Reliability"

TO MAKE WAY FOR FRESH STOCKS

GIANT CLEAR GENUINE

CRYSTAL DIODES
G.E.C. type, Glass wire ends. 3/3 each. B.T.H. Type, Plastic. 3/- each.

6" ENLARGER LENSES
Oil-filled Plastic 19/6. Carriage 2/6 extra.

C.R.T. REAR END PROTECTORS
Suitable for fitting to TV cabinets. 2/6 each.

CONDENSERS
TERRIFIC REDUCTIONS

TUBULAR WAXED
500 V.W. .1, .01, .02, .05, .001, .002, .005, etc., etc. 6d. each, 5/- doz.

MINIATURE MICA
100, 200, 300, 500 PF, etc. 6d. each, 5/- doz.

CERAMIC AND SILVER MICA
All values from 4½d. each, 4/- doz.

MINIATURE
.1, .01, .001, .02, .002 mfd., etc. 7½d. each, 6/- doz.

CHROME TWO-SECTION MICROPHONE STANDS
15/- each.

8 mfd. 450 v.w. 2/3
8 mfd. 500 v.w. 2/11
8+8 mfd. 500 v.w. 4/6
8+16 mfd. 500 v.w. 5/3
8 mfd. 350 v.w. 1/6
16 mfd. 350 v.w. 2/6
50 mfd. 12 v.w. 1/11
25 mfd. 25 v.w. 1/11
.04 mfd. 12.5 Kv., latest plastic case, single bolt fixing. 7/6.

MINIATURE BIAS
10 mfd. 25 v.w. 10½d. each, 9/- doz.

32+32 mfd. 350 v.w. and 25 mfd. 25 v.w. in single aluminium can. Latest fixing. 4/11 each.

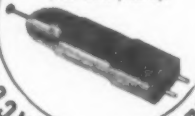
CAR RADIO
ROMAC
6 valve superhet, with R.F. stage 2 wave bands. Supplied complete with all valves. BRAND NEW AND UNUSED. In perfect working order.

Less than Half-Price
£15.19.6
CARRIAGE & PACKING 10/- EXTRA

CAR RADIO SUPPRESSORS
For distributor and plugs. 9d. each, 7/6 per doz.

LOCTAL VALVE-HOLDERS
Amphenol. 6d. each, 5/- per doz.

ACOS REPLACEMENT XTAL PICK-UP CARTRIDGE • 7/6 EACH •
Size: 2¼in. long, ¾in. wide, ¾in. high. Repair or make your own pick-up.



32+100 mfd. 450 v.w. condensers. 7/6 each.

100+200 mfd. 350 v.w. condensers. 9/6 each.

EPICYCLIC DRIVES
Standard type, 1/6. Special double type, 2/11.

NEON INDICATORS
Ideal for experimental purposes. 1/3.

6 VOLT 90 A.H. CAR BATTERIES
Ex-American Army. Absolutely perfect, brand new and unused, in maker's original packing case. Size: 9in. wide, 7in. deep, 8in. high. In genuine hard rubber case.
LASKY'S PRICE **79/6**
Carriage and packing 7/6 extra.

FUSED SAFETY TEST PRODS
3/11 PER PAIR

L. & M.T.R.F. COILS
5/11 per pair.

MAINS DROPPERS
1,000 ohms, .2 amp., 800 ohms, .3 amp. 2/- each.

USED CATHODE RAY TUBES
For callers only
9in. 35/-
12in. 55/-
These tubes have h-c. shorts, and/or ion burns. They are ideal for experimenting and testing purposes.

THROAT MICS
Low level. With band. 2/6.

MIDGET POT. METERS
½ Meg. with switch. 3/11.

LASKY'S
Lasky's (Harr
370 HARROW ROAD, PA
(Opposite Paddington Hospital).
Telephones: CUNningham 1979 and 7214.
Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

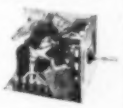
JUNE ANCE REDUCTIONS

LIMITED QUANTITIES AVAILABLE FOR ONE MONTH ONLY

LASKY'S RADIO — World Renowned for Service & Reliability

SOLON ELECTRIC SOLDERING IRONS
Oval bit .. .. 19/-.

COIL PACKS



No. 1. 3 Wavebands, 12-53 metres, 35-100 metres, 200-550 metres. ¼in. spindle, 1¼in. long wavechange switch. Completely assembled and wired. Size: 4in. x 4in. x 3in. BRAND NEW.
LASKY'S PRICE 16/-
Postage 1/- extra.
Circuit available price 1/-.

No. 2. Midget Coil Pack, 3 wavebands. Standard long, medium and short. ¼in. spindle, 2in. long wavechange switch. Completely assembled and wired. Size: 3¼in. x 1¼in. x 2¼in. BRAND NEW.
LASKY'S PRICE 24/6
Postage 1/- extra.
Circuit available price 1/-.

ALL OTHER TYPES AND MAKES O. COIL PACKS AVAILABLE. Osmor, Weymouth, Wearite, etc., etc.

J RA 2. 10-12 WATTS CHASSIS AMPLIFIER

Uses an L63 feeding 2 KT61s in push-pull type. U50. Size: 6in. x 17in. on 9in. chassis.
LASKY'S PRICE
Carriage and packing 10/- extra.

£6 . 19 . 6
THE LAST FEW

WEARITE I.F. TRANSFORMERS. Type 550

Permeability tuned, 445-520 Kc/s. Type 551. Critically coupled, with top grid connection. Type 552. Choke coupling for feeding diode circuit. Q/15, inductance 700 micro-henries at 465 Kc/s.
Bandwidth of each of the above transformers is 7-20 Kc/s at 2-20 db. Size: 3¼in. high, 1¼in. square. Supplied with fixing screws and nuts.
12/6 per pair

EX-GOVERNMENT VALVES

KT2	3/6
VU120A	2/6
VU111	3/6
APV4	12/10
57	3/6
32E	2/6
NGT1	5/-
PT25H	5/-
MS/PEN	3/6
E1148	2/6
RK34	2/6

RK 34 **2/6**

MH14, 4/6. 1D5, 11/-.
Screen Grid. 2 v., 4/6. S130, 4/6.
Tungar charger recs. from 12/6.
HUNDREDS OF OTHER TYPES IN STOCK.

ROMAC 25 WATT AMPLIFIERS

616s in push-pull, complete with radio tuner unit.
BRAND NEW AND UNUSED.

£25 . 0 . 0
CARRIAGE & PACKING 25/- EXTRA

CHARLES AMPLIFIERS AND TUNER UNITS
Various stages of completion. From 15/- each.
CALLERS ONLY.

3" C.R. TUBES
3in. C.R. Tubes. EMI 4/1. 4/11 each.
CALLERS ONLY.

INTER-COM CHASSIS Incomplete

Extn. Cabinets. 9/11 each.

Master chassis. Size: 9in. wide, 4in. deep, 8in. high. Contains 16 + 16 mfd. 450 v.w., 2 Yaxley switches, valveholders, transformers, etc. Less S.R Switch and valves.

15/- each.

Master Unit Cabinets, 18/6 each.

T.V. MASKS

12in. New	15/-	9in. Soiled	5/-
12in. Flat face	15/-	9in. New	7/6
12in. Soiled	7/6		

ARMOUR GLASS

9in.	3/-
12in.	4/-

RADIO

ow Road) Ltd.,
DDINGTON. LONDON. W.9

TERMS: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

LASKY'S RADIO

World Renowned for Service & Reliability

TWO GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature type. With perspex dust cover and trimmers. Size: 1¼in. × 2in. × 1¼in. ¼in. spindle. **LASKY'S PRICE 8/6.**

No. 2. Midget type. Size 1¼in. × 1¼in. × 1¼in. ¼in. spindle. With trimmers. **LASKY'S PRICE 8/6.**

No. 3. Standard type. Size: 2¼in. × 2¼in. × 1¼in. ¼in. spindle. **LASKY'S PRICE 6/6.**

Postage 9d. per item extra.

THREE GANG TUNING CONDENSERS. .0005 mfd. Size: 3¼in. × 2¼ × 1¼in. ¼in spindle. **LASKY'S PRICE** 7/6. Postage 1/- extra.

BRANDENBERG BRAND NEW R.F. E.H.T. UNITS

6-9 k.V. output. Supplied complete with 6V6 and EY51. **£6/6/-.**

HIGH VOLTAGE CONDENSERS

.1 × .1 mfd. 3 kV. Price 8/6 each. .1 × 1 mfd. 5 kV. Price 12/6 each. .25 mfd. 2.5 kV. Price 6/6 each.

TELEVISION PRE-AMPLIFIERS

For London frequency. 2 Stage, uses 2 6F13 valves. Completely wired, ready for use. **LASKY'S PRICE 15/-** (less valves).

CATHODE RAY TUBES

All types and sizes available from stock. Brand new and fully guaranteed.

12in., from £18 4 10
15in., from £22 16 10
16in., from £24 6 5
14in. rectangular, from £22 8 5
17in. rectangular, from £26 19 8

VCR97 C.R. TUBES. BRAND NEW AND UNUSED.

In makers original sprung wood transit case. **LASKY'S PRICE 40 -** Carriage 5/- extra.

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS

(Cathode ray.) .001 mfd. 6 kV. Price 4/6 each. .001 mfd. 12.5 kV. Price 7/6 each. .1 mfd. 7 kV. Price 15/- each.

T.C.C. T.V CONDENSERS

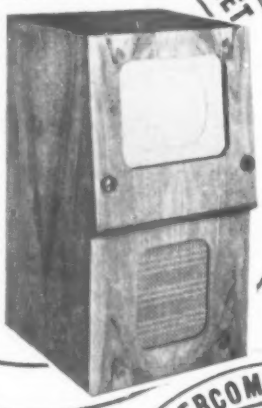
100 mfd. CE10LE ..... 14 -
250 mfd. CE10DA ..... 10 -
2,500 mfd. 6 v.w. CE25AA 6/9
All other types in stock.

E.H.T. TRANSFORMER FOR VCR97

Primary 200-250 v., 50 c.p.s. Secondary: 2.5 kV. 4 mA.; 4 v. 1.1 a.; 4 v.(CT) 1.5 a. **LASKY'S PRICE 45/-** Postage 1/6 extra.

DE-LUXE TELEVISION CONSOLE CABINET

For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster, "Practical Television," "Practical Wireless," and "Wireless World" televisors. **LASKY'S PRICE £8.10** Carriage 12/6 extra. Outside dimensions of cabinet: 17¾in. × 16¼in × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.



MAINS TRANSFORMERS

All 200-250 volts c.p.s. primary. Finest quality, fully guaranteed.

MBA/3. 350-0-350 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. An ideal replacement trans. Price 21/-

MBA/5. 350-0-350 v. 125 mA., 6.3 v. 4 a., 5 v. 3a. With mains tapping board. Price 27/6

MBA/6. 350-0-350 v. 100 mA., 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6

MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts Price 21/-

AT/2. Auto transformer. 0-10-120, 200-230-250 volts, 100 watts. Price 19/6

AT/4. Auto transformer. 100 volts and 230 volts Step up or down. 60 watts. Price 9/6

T/V SCANNING COILS

T.V. SCANNING COILS

Manfrs. surplus, high resistance frame, low resistance line. 12/6. Low impedance line and frame. 14/6. Plessey. Low impedance line, and frame. 25/-.

8in. CLOSED FIELD LOUD-SPEAKERS

Ideal for television receivers. Less o/trans. 3 ohms. will not affect your C.R. tube. 15/-.

BRAND NEW INTERCOMMUNICATION SETS A/C-D/C

Fitted in plastic cabinet, complete with all valves. Supplied with one extension as illustrated.

£8/19/6 Complete

METAL RECTIFIERS

125 v. 60 mA. 3/11
125 v. 100 mA. 4/3
50 v. 5 mA. 1/6
12 v. 1 amp. 3/6
12 v. 1 amp. 6/9
6 v. 1 amp. 6/9
230 v. 300 mA. ..... 21 -
570 v. 1.2 amp. 29/6

FILAMENT TRANSFORMERS

2 v. 2 amps. 4/11.

Special Transformer. 30 volts at 2 amps., with the following tappings:—3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. 21/-.

PUSH PULL OUTPUT TRANSFORMERS

Suitable for PX4's. 8/6.

EXPANDED METAL SPEAKER FRET

Metal finished silver.
Size: 12in. × 12in. **LASKY'S PRICE 3/11** per piece
Size: 12in. × 18in. **LASKY'S PRICE 5/11.**

YAXLEY SWITCHES

Midget type with long spindle. 4 pole 3 way. 2/11

LASKY'S

Lasky's (Harr

370 HARROW ROAD. PA

(Opposite Paddington Hospital)

Telephones: CUNningham 1979 and 7214

Hours: Mon. to Sat. 9.30. a.m. to 6 p.m., Thurs. half day 1 p.m.

P.M. LOUDSPEAKERS

All less o/trans. New and unused. First quality.

3in.	12/11
5in.	12/6
6½in.	12/6
8in.	14/6
10in.	28/6
12in.	75/-

SMOOTHING CHOKES

20 mA. 40 H.	3/11
40 mA. 8 H.	3/11
40 m/a. 10 H.	4/3
100 mA. 10-20 H.	7/6
150 mA. 3 H.	3/3

WIRE WOUND POT METERS

Most values. Short spindle, 1/9 each. Top Quality Makes.

TAG STRIPS

Price 1d. per way, i.e., 4-way 4d.

PRESS BUTTON SWITCH UNITS

Supplied with buttons. These units have many useful applications.
LASKY'S PRICE 3-way 1/11. Post 6d. extra.
9 way, 3/11. Post 6d. extra.

CO-AXIAL CABLE

Standard impedance.
Single screened, 1/- per yard
Twin screened, 1/6 per yard.
Twin balanced feeder, 7½d. per yard.
Post extra. Any length cut to your requirements. 10% discount on 50 yards or more.

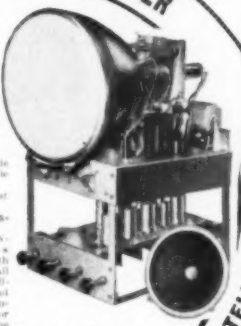
AN ALL-WAVE RADIO RECEIVER

5 Valve s'het. Not a kit, but a factory-built job, fully assembled, aligned and tested. For A.C. mains, 200-230 volts. Features include 5 new Brimar valves, 8in. p.m. speaker, variable tone control, large edgelit dial 7½in. square, 4 watts output, sockets for p.u. and extension speaker, 465 Kc/s. I.F., A.V.C., 2 speed tuning.
LASKY'S PRICE £10 19 6, complete with valves and speaker. Carriage and packing 10/6 extra.

B.S.R. GRAM UNITS

3-speed unit, with pick-up and change over crystal head. Supplied with two sapphire styli **£9/19/11.**

BUILD THE VIEWMASTER



The television set you can build at home from standard parts.
Weyvue, Kirk o' Shotts, Holme Moss, Sutton Coldfield and Alexandra Palace operation. Brilliant high definition black and white picture.
Superb reproduction.
Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.
Incorporates all the latest developments.
Television for the home constructor at its finest.
Send to-day for the CONSTRUCTION ENVELOPE, a 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions. Model "A" for use in London and Home Counties. Model "B" for use in Sutton Coldfield Area. Model C for Holme Moss. Model D for Kirk o' Shotts. Model E for Weyvue.

PRICE 7 6 per Post free copy.

ALL COMPONENTS IN STOCK & SOLD SEPARATELY

TRIODE FOCUS MAGNETS

Fitted with vernier control. 35 mm diameter 15/-.

W.B. & PLESSEY T.V. COMPONENTS

Line EHT Trans.	32/6
Frame Trans.	25/6
3 Mc/s Boost Choke	5/9
Width control	10/-
Scanning coils	33/3
Main choke	15/6
Focus ring	22/6
Heater Trans.:	
WB/103	42/-
WB/130A	52/6

C.R. Tube supports, front and rear, 21/6.

METAL RECTIFIERS

FOR TELEVISION

WX3	3/9
WX6	3/9
14A86	20/4
14D36	11/8
36 EHT 25 1.8 kV.	14/6
36 EHT 35 2.5 kV.	19/-
36 EHT 40 2.9 kV.	21/7
36 EHT 45 3.4 kV.	23/8
36 EHT 50 3.6 kV.	26/1
36 EHT 100 7 kV.	29/6

ALLAN LINE E.H.T. TRANSFORMERS

Suitable for use with the Viewmaster. 29/6.

PLASTIC SPEAKER GRILL

Finished gold, 16in. × 12in. 6/6 per piece.

SURPLUS T/V COMPONENTS

MULTI RATIO FRAME OUTPUT TRANS. 10/6

Frame blocking oscillator transformer. 4/6

LINE E.H.T. TRANSFORMER

(With filament winding for EY51). 12/6

EX-A.M. COMMUNICATION RECEIVER TYPE R1155

BRAND NEW IN WOOD TRANSIT CASE. Aerial-tested factory despatch. Supplied complete with 10 valves. Circuit: R.F.O., A.V.C., B.F. Amp., two I.F. stages, magic eye, etc. 5 frequency ranges: 16.5-7.0 Mc/s.; 7.5-3.0 Mc/s.; 1,600-600 kc/s.; 500-200 kc/s.; 200-75 kc/s.
LASKY'S PRICE
Carriage (in wood case), 7/6 extra.
Full modification data and circuit details supplied.

Lasky's Price £12 19 6

CARBON POT METERS

All with long spindle, ¼, ½, 1 and 2 meg.
LASKEY'S PRICE, less switch **WITH SWITCH 4/3 EACH** 3/3 each

RESISTANCES

All values and wattages in stock.

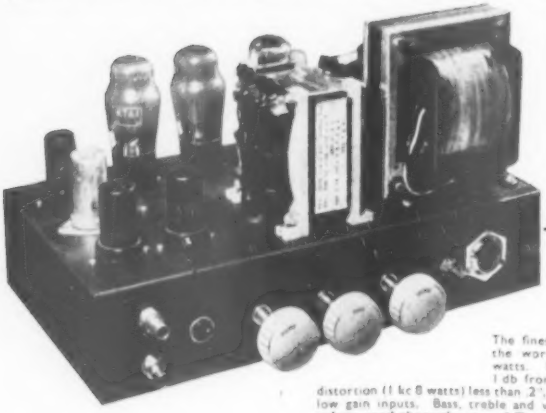
RADIO

ow Road) Ltd.,

DDINGTON. LONDON. W.9

Terms: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

GARLAND



PERIODICALS STOCKED

"Wireless World."
"Electronic Engineering."
"Practical Wireless."
"Practical Television."
"Radio Constructor."
(Add 3d. to cost for post.)

GARLAND ACIV AMPLIFIER

The finest amplifier at the price in the world. Maximum output 11.5 watts. Frequency response within 1 db from 20-30,000 c.s. Harmonic distortion (1 kc 8 watts) less than .2%; 26 db feedback. High and low gain inputs. Bass, treble and volume controls. **Standard valves used throughout.** **15 GNS.** Plus 15/- carriage, etc.

This amplifier can be supplied in kit form, with fully punched chassis, all valves and components, circuits, wiring diagrams and instructions, for **£13** plus 15/- carriage, etc.

Circuits and instructions **5/-**, credited on purchase of complete kit.

MOTEK RECORD-PLAYBACK & ERASE HEADS

High Impedance (1,000 ohm) chromium-plated enclosed type. Genuine half-track with half-thou gap of beryllium copper. Record playback heads are wound on Mumetal laminations, and Erase Heads on Radiometal. Single hole fixing enables ready use for replacement purposes or for conversion of existing tape decks to high impedance. Wide frequency range. Pressure pads not required. **Price either type 39/6**

★ NEW ELECTROLYTICS

A small selection from our range

8μF. 450 v. cardboard covered wire-end, **2/9** each; 8μF. 475 v. ditto, 3/- each; 8-8μF. 450 v. cardboard, 1in. diam. x 2¼in., **4/-**; 8-16μF. 450 v. metal tub, 1¼in. diam. x 2in., **5/6**; 8-16μF. 450 v. metal, 1in. diam. x 2in., **4/6**; 32μF. 450 550 v. TV type, 1¼in. diam. x 4¼in., **7/-** each; 16-24μF. 350 v. metal, 1¼in. diam. x 2in., **5/3** each; 32-32μF. 350 v. ear-mtg. with clip, 1in. diam. x 3in., **5/3** each; 25μF. 25 v. cardboard wire-end, **1/9** each; 50μF. 50 v. ditto, **2/-**.

★ SPECIAL OFFER

Solar 25μF. 25 v. ear-mtg. with clip, **1/3** each, **12/-** doz.

★ HIGH VOLTAGE MICA CONDENSERS

Ceramic pot type, 10 C 2178 0.0002μF., 5 kV working, high H.F. current, **2/6** each. Flat bakelite-cased type ZA2837, 0.001 μF, 5 kV. A.C. test, 5 a. at 2-8 Mc.; size 3¼in. x 1¼in. x 5 8in., suitable tx or tv, **1/9** each, **15/-** per doz.

★ UNDRILLED CHASSIS

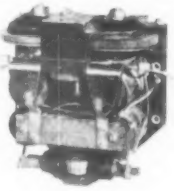
In 20 s.w.g. bright mild steel: Four-sided, size 13in. x 7in. x 2¼in., **7/6** each; two-sided with two straps, size 12in. x 4in. x 2¼in., price **3/9** each.

RESISTORS AND CONDENSERS

Wide range. Large stocks. See our previous advertisements

P.A. COMPONENTS OFFER:

By a famous manufacturer; limited number only. Mains transformer, pri. 10-0-200-220-240 v. Sec. 600-500-300-0-300-500-600 v. 250 mA., **45/-**. Heater transformer, Pri. 10-0-200-220-240 v. Sec. 6.3 v. 6 a. C.T., 5 v. 4 a. C.T., 5 v. 2 a., 35 v. 20 mA., **22/6**. Choke, 20 H. 250 mA., **20/-**. P.P. Output tfmr, 22 to 1, 30 watt, **25/-**. Set of four components, **£5**. These are new goods, not surplus.

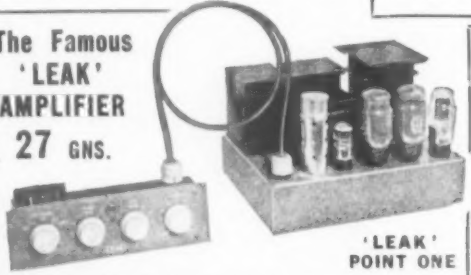


★ *Have you any motors like this?*

24v DC, WITH CLUTCH & BRAKE

Any quantity purchased.

The Famous 'LEAK' AMPLIFIER 27 GNS.



'LEAK' POINT ONE

THE LEAK "POINT ONE," TL 12 12 watt triple loop feedback amplifier, price **27 guineas**, and the RC PA U remote control pre-amplifier, price **9 guineas**, need no introduction. Their quality and craftsmanship, unsurpassed anywhere in the world, have been given tangible recognition, by orders from the B.B.C. and other national broadcasting authorities, and from quality enthusiasts everywhere.

EPICYCLIC DRIVES

Reduction 5:1, for ¼in. spindle. Price **1/6** each, **12/-** per doz. With 1¼in. diam. drum, **1/9** each, **15/-** per doz.

MAINS TRANSFORMERS

All primaries 200-220-240 v.

MT1: 250-0-250 v. 80 mA., 0-4-6.3 v. 3 a., 0-4-5 v. 2 a., **20/-** each.
MT2: 350-0-350 v. 80 mA., 0-4-6.3 v. 3 a., 0-4-5 v. 2 a., **20/-** each.
MT3: 0-30 v., tapped to give 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10v., 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., all at 2 a. The ideal model-makers transformer. **19/6.**
MT4: Charger tfmr, 0-4 v. 4 a., 10 v. 4 a., 20 v. 3 a., **19/6.**
MT5: Auto; 0-10-120-200-230-250 v. at 100 w., **19/6.**
137: Heavy-duty shrouded; 250-0-250 v. 120 mA., 6.3 v. 7 a., 5 v. 5 a., **37/6.**
190: Heavy-duty shrouded; 350-0-350 v. 120 mA., 6.3 v. 5 a. C.T., 5 v. 5 a., **42/6.**

BROS, Ltd.

THE 'GARLAND' TAPE RECORDER £37/10/0

including a 1200ft. reel of Scotch Boy Tape and a spare spool. Carriage etc. 15/-. Crate £1 (not charged if you undertake to return carriage paid to us).

No wiring or soldering to be done—just plug in and record and play back from Radio, mike or pickup. Incorporating the new Lane Tape Table and the UE7 Amplifier, housed in a de-luxe walnut veneered cabinet, and supplied complete with a 1,200ft. reel of tape and a spare spool.

RECOMMENDED MICROPHONES are the: Lustraphone CS1/Z at £5/15/- (table stand £1/1/- extra); Ronette HM7 Crystal Microphone at £2/15/-; and Ronette B110 Crystal Microphone at £2/2/-.

(Under chassis view)

THE NEW LANE TAPE TABLE

A new version of the popular "Lane." Three motors, very fast wind-on and rewind (under one minute); heads are high impedance on mu-metal laminations, with half-thou gap, giving a half-hour playing time on each side of a 1,200ft. tape reel.

£16.10.0 plus 10/- carriage.

THE UE7 RECORD-PLAYBACK AMPLIFIER

An exceptionally stable magnetic recording amplifier for high impedance heads (Lane, Motek, Sonek, Burgoyne); specially recommended for use with the Lane Tape Table. High and Low Gain inputs, for mike, radio or pickup. Bass and treble equalisation. Variable tone control. Neon recording level indicator and mains on-off indicator. Supplied completely wired and tested for use on A.C. mains, 200-250 v. complete with 8in. Elac P.M. speaker, and instructions for operation and simple connection to tape recorder. STANDARD VALVES USED THROUGHOUT. **12GNS.** Plus 7/6 carriage, etc.

Can also be supplied in kit form, with full-punched chassis, all valves and components, and detailed circuits, wiring diagrams and instructions, at **£9.15s.** plus 7/6 carriage.

TAPE RECORDER CABINETS

Veneered walnut, to take UE7 Amplifier and Lane Tape Table **£4.10.0** De Luxe, **£6**

COLLARO HIGH TORQUE MOTORS

4-pole shaded pole; 1,500 r.p.m.; for A.C., tapped 100-125v and 200-250v. State if clockwise or anti-clockwise required. Ideal for tape recorders, fans, etc. **37/6**

BAKELITE CABINETS

Strong moulded cabinets in brown bakelite for Decca-type 3-speed gram. motors. Also suitable Portable Amplifier Case, Speaker, etc. Outside dimensions (closed) 15¼in. x 10in. x 5¼in. Thickness of wall 1/6in.

25s. plus 3/6 post and packing.

SCOTCH BOY HIGH COERCIVITY TAPE

is recommended for use with this recorder; additional 1,200ft. reels can be supplied at **35/-** each spare plastic spools can be supplied at **4/-** each.

COLLARO RCS11 SINGLE-SPEED AUTO-CHANGER. Non-mixing, plays eight 78 r.p.m. 10in. or 12in. records. Supplied with Acos made plug-in pick-up head incorporating sapphire stylus. Magnetic, price £11 14 11, incl. P.T. Crystal price, £12 3 2, incl. P.T.

COLLARO AC47 SINGLE-SPEED TURN-TABLE AND MOTOR. Centre-drive governor-controlled heavy induction motor, for A.C. 100-130 v. and 200-250 v., with 12in. turntable. Variable speed. Price **£6 13 4**, incl. P.T.

COLLARO AC 514 RECORD PLAYER. For 78 r.p.m. records. Rim-drive motor, with auto. stop, turntable, pick-up with plug-in magnetic head. Price **£6 9**-, incl. P.T.

DECCA THREE-SPEED GRAM MOTORS. For 33⅓, 45 and 78 r.p.m. Instant single-lever speed selection. For A.C. only, 100-250 v. 50 cycle operation. Price (incl. P.T.) **£7 3 4.**

DECCA TURNOVER PICKUP. A high fidelity crystal pickup with turnover head (two sapphires) for use on the above or other multi-speed motors. Price (incl. P.T.) **£3 19 4.**

METAL RECTIFIERS

Type RM2, 125 v. at 100 mA. Two in series required for mains voltage. Price **4/-** each. Type 14D/972, 250 v. 25 mA. (with reservoir condenser). Small size ideal for test equipment, also in place of 14D/36 in T.V circuits. Price **6 6** each. 6 v. 1 a. half-wave (or full wave with C.T. tfmr.), price **5/-** each; 12 v. 1 a. bridge, price **8 6** each; 12 v. 4 a. bridge, price **22 6.**

C.R. TUBES

5CP1. Electrostatic intensifier-type C.R.T. diameter 5in. max. second anode voltage 2 kV. max. intensifier anode voltage 4 kV., medium persistence screen. Brand new in original crate or carton, **32 6** each.

POTENTIOMETER OFFER

35 k. miniature ¼ watt preset carbon pots. **9d.** each, 7/6 per doz., **50/-** per 100, **£12** per 1,000.

PRIORITY TO DEFENCE & EXPORT ORDERS.

ALL GOODS NEW AND UNUSED, OTHERWISE STATED. GOODS SHOWN AS EX-EQUIPMENT HAVE BEEN FULLY TESTED AND ARE IN GOOD WORKING ORDER. **PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND ADDRESS.** POST ORDERS TO OUR DEPTFORD ADDRESS. EARLY CLOSING THURSDAY. OPEN ALL DAY SATURDAY.

AMPLIFIER A.C.11 This popular amplifier is still available for those who desire good quality at a low cost. Output is 4 watts, and volume and tone controls are incorporated. High-grade output transformer. H.T. and L.T. supplies are from mains transformer. Amplifier wired and tested, **£6 2 6**, plus 5/- carriage.

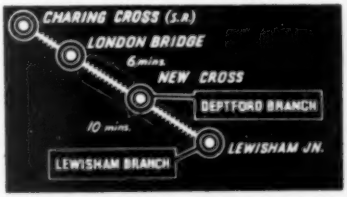
GARLAND BROS, Ltd.

CHESHAM HOUSE, DEPTFORD BROADWAY, S.E.8

Telephone: TIDEWAY 4412/3

5 OBELISK PARADE, LEWISHAM, S.E.13

Telephone: LEE GREEN 4038



BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE

You're SURE to get it at

STERN'S

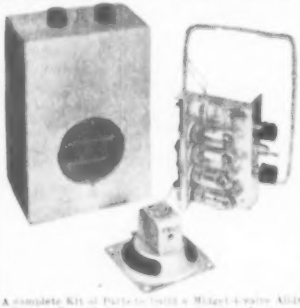
ESTABLISHED 25 YEARS

ALL KITS INCLUDE "EASY TO FOLLOW" POINT-TO-POINT WIRING DIAGRAMS

A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.
Designed to operate on A.C. mains 200/240 volts, or by an "All-dry" battery. The set is so designed that the mains section is supplied as a separate unit which may be allied at any time. The Kit therefore can be supplied (a) as an All-dry Battery Superhet Personal Set, which can then be accommodated in the Attache Case as illustrated above (size 9½in. × 4½in. × 7½in.). This is attractively finished in Dark Green or Blue Rexine (b) or as a Combined Mains/Battery Superhet Portable Receiver for which a polished Wood Cabinet is available to accommodate both Mains Unit and Battery together. Circuit incorporates delayed A.V.C. and Pre-selective Audio Feedback. Kit is complete in every detail and includes ready wound frame aerials, fully aligned I.F. Transfs., and drilled chassis, etc. Overall size of assembled chassis 8½in. × 4½in. × 7½in.
We can supply the set either as a complete Kit of Parts for £10 7 6 (incl. P.T.) or as Universal Mains Unit, or for supplying the components separately. The complete Assembly Instructions, which include full price details (including prices of individual components), Circuit and Component Layout, etc., are available for 1 9 (incl. postage). Attache case as illustrated 37 6.

A T.R.F. BATTERY "PERSONAL" KIT



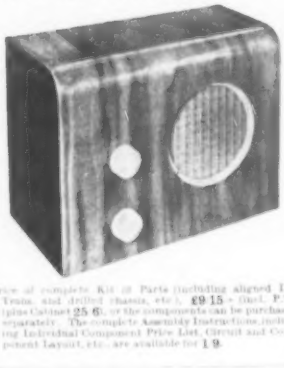
A complete Kit of Parts to build a Midget 4-valve All-dry Battery Portable Set, covering medium wavebands.
Consists of Regenerative T.R.F. circuit, employing Flat Tuned Frame Aerial with Dense Iron Dust Cored Coil. Valves (one sp. 4-v. L.F.4-v. (R.F. Amp.) and Det.) 1R5 and 1S4 output.
Kit is complete in every respect and includes drilled chassis and latest type Rola 5in. P.M. speaker. Overall size of assembled chassis 4½in. × 9½in. × 5¾in.
We can supply the Complete Kit (less cabinet) for £6 12 6 (incl. P.T.), or by supplying the components separately. The Complete Assembly Instructions (including individual component prices, Circuit and Component Layout, etc.) are available for 1 - (incl. post).

A KIT OF PARTS

Complete in every detail, to build a 3-valve Amplifier for A.C. (50) mains 200/250 volts.
Has an output of 3 watts, and incorporates a Tone Control.
Valves (one sp. 7S8A, GZ 32).
Our price is £4 18 9 for complete kit including a matched 6½in. P.M. speaker.
This Amplifier can also be supplied assembled and ready for use for £5 18 6.

A MIDGET 4-STATION "PRE-SET" RECEIVER

A complete Kit to build a 4-Station "Pre-Set" Superhet Receiver for A.C. mains operation.
The set is designed to receive any three stations on medium waveband and one on long wave, each station being received by the turn of a Rotary Switch—No Tuning being necessary.
Kit is of midget size, being 9½in. × 4½in. × 7½in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price.



Price of complete Kit of Parts (including aligned I.F. Trans. and drilled chassis, etc.), £9 15 - (incl. P.T.) (plus Cabinet 25 6), or the components can be purchased separately. The complete Assembly Instructions, including Individual Component Price List, Circuit and Component Layout, etc., are available for 1 9.

STERN'S "RADIO TUNER MANUAL." Price 2 6.
(Plus 3d. Post). Contains complete and detailed assembly instructions showing how to make—
A 1-Valve T.R.F. Tuning Unit, covering Long and Medium Wavebands.
A 4-Station "Pre-Set" Superhet Tuning Unit, producing 3 Stations on Medium Waveband and 1 on Long Waves.
A 2-Valve Superhet Tuning Unit, covering Short, Medium and Long Wavebands.
Each Tuner is for A.C. Mains operation. Circuit Diagrams and Practical Component Layouts are shown, together with complete component Price Lists.

THE WIRELESS WORLD MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including Valves and Moving Coil Speaker for £3 10 -, including Designer's complete building instructions (these are available separately for 9d.).

THE "SUMMER ALLDRY" BATTERY PORTABLE

As published in June issue of "Practical Wireless." We can supply, from stock, all the components to build this Midget 3-valve Portable for £3 2 - (less valves). This also includes Hide, top panel and alv. sheet for chassis. The complete article and circuit, including Practical Layout and Price List, is available for 9d.

PICK-UPS

Cosmocord "G.P.20," for standard records, £3 11 5; interchangeable (G.P.19) Head for L.P. records, £2 3 4.
Decca lightweight "turnover Head" type, for L.P. and standard records, £3 19 2.
Marconi, Standard, lightweight Magnetic, £1 15 10.
Marconi Matching Transformer, 7 6.
Goldring, Standard, lightweight, Magnetic, 35 10.

THE WIRELESS WORLD 3-VALVE SET

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.
We are able to supply all of the components to build this set, as designed, and specified in the Feb. 1950 issue, including the drilled chassis, valves and moving coil speaker, etc., at the following prices:—
To construct complete chassis, less dial and drive assembly, £5 5 -. Ditto, including dial and drive assembly, £6.
To construct the complete set, including dial and drive assembly and cabinet, £7 3 6.
Overall size of cabinet is 7½in. × 5½in. × 11½in.
A reprint of the designer's article, giving Circuit and Assembly Instructions, this is available separately for 9d., together with a Practical Component Layout is included with each of above assemblies.

BATTERY CHARGER KITS

All Kits incorporate Metal Rectifiers, and are for use on A.C. mains 220-250 volts. All Kits include an easily followed Wiring Diagram.
For charging 2-4 or 6 v. batteries at 1 amp., £1 8 -.
For charging 6 volt battery at 1 amp. with Variable Resistor and Meter, £2 12 6.
For charging 12-volt battery at 1 amp., £1 9 3.
For charging 12-volt battery at 1 amp., with Variable Resistor and Meter, £2 14 -.
For charging 6 or 12 volt battery at ½ amps., £2 1 -.
For charging 6 or 12 volt battery at 2½ amps., with Variable Resistor and Meter, £3 8 3.

THE WIRELESS WORLD MODERN CRYSTAL SET

Designed for the Pre-selection of THREE STATIONS to suit local conditions, each station being received by the turn of a rotary switch. We are able to supply all components, including drilled chassis to build this new type of Receiver, to the designer's specification, as published in October issue, for 47 4 (including cost of selected coils).
A reprint of the designer's article is available separately for 9d., together with a practical component layout, make the assembly very easy.

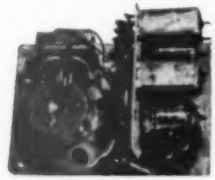
★ *Send 6d. P.O. for our STOCK LIST, it shows "hundreds" of Wireless*
When ordering please include

STERN RADIO LTD., 109

Tel.: CENtral

THE "PRACTICAL WIRELESS" "MINI FOUR" BATTERY PORTABLE

A 4-valve battery superhet receiver designed to receive 4 Pre-Set Stations, three on medium wavebend and one on long waves to suit local conditions. Each station is obtained on the set by the turn of a rotary switch. No tuning is necessary.

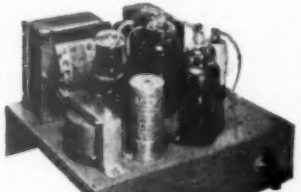


It is of midget size, being only 44in. × 9in. × 4¾in. when completely built, and is very easily assembled from diagrams supplied.

Cost of all components to build this set, in accordance with the design, including a drilled and cut chassis and panel, and new valves, is **£9 10**/- (or less valves for **£6 7 6**). Attractive carrying case finished in blue leatherette, **16 9**. Complete constructional data with a blue print, which shows the practical component lay-out and wiring diagram, together with an individual component price list, is available separately **1 6**.

Our Battery Eliminators (illustrated below) available in kit form are suitable for use with this set.

A QUALITY "PUSH-PULL" AMPLIFIER KIT



A Kit of Parts to build a 6-8-watt Push-Pull Amplifier for operation on A.C. mains 200-250 volts.

Incorporates a simple arrangement to enable either a magnetic, crystal, or light-weight pick-up to be used.

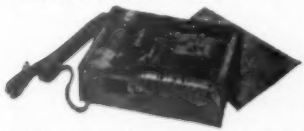
A 10-watt Output Transformer is designed to match from 2 to 15 ohm speakers. Tone controls incorporated. The overall size of the assembled chassis is 10in. × 8in. × 7¼in. high. Price of kit complete in every detail, including drilled chassis and valves, **£6 12 6**. Component layout is supplied.

Price of assembled chassis, supplied ready for use **£8 2 6**.

"PERSONAL SET" BATTERY ELIMINATOR

A complete kit of parts to build a Midget "All-dry" Battery Eliminator, giving approx. 60 volts and 1.4 volts.

This Eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 60 volts.



The kit is quite easily and quickly assembled and is housed in a light aluminium case, size 4¾in. × 10in. × 3¾in. Price of complete kit, with easy to follow assembly instructions, **42 6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled Unit 7in. × 2¼in. × 14in. Price **47 6**.

You're SURE to get it at

STERN'S

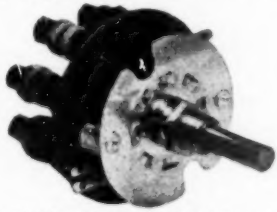
ESTABLISHED 25 YEARS

TWO NEW DENCO ULTRA MIDGET SUPERHET COIL TURRETS

Both having a Rotary Turret Action

(a) The C.T.9 Turret consists of 4 STATION "PRE-SET" UNIT, from which any three Stations on Medium Wavebend and one on Long Waves can be received by a turn of the Turret Switch.

(b) The C.T.10 Turret being a 3 Waveband Coil Pack, incorporating a fourth switch position providing for completely switching out Radio when using gram. The complete coverage is: Long Wavebend 700 to 2,000 metres. Medium Waves 190 to 570 Metres and Short Waves 19 to 50 Metres.



The outstanding advantages these units have over other similar units can be readily seen, the main features being:

(a) Neat and Compact, the overall size being only 2¼in. dia. × 1¾in. deep.

(b) Fitting is simplicity itself, each Turret having one hole fixing and requiring only four connections.

(c) The Rotary Turret design switches the actual Coils, which incorporate variable iron dust cores, on to positive contacts, thereby reducing stray capacities to the absolute minimum.

(d) They are supplied Factory wired and aligned and have been designed to operate with any conventional circuit arrangement of 465 kc/s., and due to their unique design are extremely sensitive and efficient.

Price: C.T.9 Turret, **42 10**. C.T.10 Turret, **52**/-.

A complete Receiver circuit together with leaflet containing all necessary data is included with each Turret. These can be supplied separately for **6d**.

THE FAMOUS W.B. "STENTORIAN" RANGE OF P.M. SPEAKERS

Size.	Impedance.	Watts.	Price
2½in.	2-3 ohms.	1	18 6
3½in.	"	2	19 6
5in.	"	2½	21/-
6in.	"	3	24 6
7in.	"	3½	23 6
8in.	"	5 (also in 15 ohms.)	29 6
9in.	"	7	39 9
10in.	"	10 (also in 15 ohms.)	44 6
12in.	15 ohms.	15	£9

New Mfrs. Surplus Speakers. All 2/3 ohms. 2½in. 15/-; 3½in., **14 6**; 5in., **14 6**; 6½in., **16 9**; 8in., **18**/-; 10in., **25**/-; New Type 8oin., 3in., **21**/-; 4in., **22 6**.

Output Trans. Midget 60-1 (or 90-1) 1in. × 1in. × 1¼in. **3 9**. 5-watt Multi-ratio, 12 tappings between 2-1 and 114-1 (some C.T.), **8 6**. Wharfedale, 12-watt, push-pull, multi-ratio, **25**/-. P/pull, 20-watt, multi-ratio, **37 6**, and many others.

New Electrolytic Condensers. Not Ex-Govt. All 450-500 volts: 8 mfd. (1¼in. × ¾in. dia.), **5**/-; 8-8 mfd. (1¼in. × 1in.), **4 9**; 16-8 mfd. (1¼in. × 1in. dia.), **5 6**; 16-16 mfd. (1¼in. × 1¼in. dia.), **5 9**; 32 mfd. (1¼in. × 1¼in. dia.), **5 9**; 32-32 mfd. 350 volt, **5 9**; Cardboard Tubular, 4 mfd. 500 v. **3 6**; 8 mfd. 500 v. **4**/-; 16 mfd. 500 v. **5 9**. Can. Standard size all 500 volts, 4 mfd., **3 6**; 8 mfd., **4 3**; 8-8 mfd., **5 9**; 16 mfd., **5 6**; 16-16 mfd., **7 9**; 32 mfd., **6 9**.

Denco I.F. Liner, for accurately lining 465 K/c. and 1.6 m/c. I.F. channels, and associate circuits. Battery operated, small and completely self-contained **49 6**.

Potentiometers. New, not Ex-Govt. 2K, 5K, 10K, 25K, 50K, 100K, 250K, ½, 1 and 2 meg. Price, less switch, **3 9**. Price with S.Pole switch, **5 9**. Price with D.Pole switch, **6 6**.

Sapphire Potentiometers. All standard with extended spindles, 5K, 10K, 15K, 20K, 25K, 50K, 100K, ½, ¼ and 1 meg., **2**/- each.

THE FAMOUS "SHAFTESBURY" RIBBON MIKE,

incorporating internal line Transformer having transformation ratio from ribbon impedance up to 500/600 ohms. Reduced from £10 10/- to **66**/-.

A special line to grid, 500/600 ohm, Transformer is also available for **25**/-.

Coils. Denco "Maxi Q," midget size, Litz wound on Polystyrene Formers, with adjustable iron cores. Available for Aerial H.F. and Oscillator 465 K/c. or 1.6 M/c., **3 11** each, or with reaction winding, **4 9**. Denco Matched pair T.R.F. Coils for long and medium waves, **8**/- pr. Weymouth matched pairs o' coils, for T.R.F. covering long and medium waves, **10 3** pr., or for Superhet covering Long, Medium and Short Waves, **12 3** pr. All types of "Wearite" P" coils in stock at **3**/- ea.

Coil Packs. Osmor Midget Coil Pack. Size 3½in. × 2½in. × 1¼in., covering S., M. and L. waves. Coils wound on Polystyrene Formers with adjustable iron cores ensure efficient performance. Factory wired and aligned. Price including full circuits for Superhet 465 K/c. Unit, **52**/- (incl. P.T.). This Osmor Coil Pack is also available for Midget Superhet BATTERY Portable sets, including a matched ready wound Frame Aerial. Price **54 9** (incl. P.T.). **Weymouth** Midget 3½ × 2½ × 1¼in. covering S.M.L. w/bands, for 465 K/c s., employing Matched Iron Cored Coils on each w/band, **51 6**.

Wearite Pack, 4½ × 3½ × 1¼in. Type 706, covers two short w/bands and medium w/band and Type 705 covers short-medium-long waves. Both for 465 k/c s. Incorporates gram. position, and employs adjustable cored coils, **53 4**.

All of the above Coil Packs including Switching, Padding and Trimmer Condensers.

L.F. Chokes. Midget 10 henry 250 ohms 40 mA., **4 6**; 20 hy. 250 ohm 60 mA., **6 6**; 20 hy. 300 ohm 100 mA., **13**/-; 5 hy. 50 ohm 250 mA, **28 6**; 20 hy. 250 ohms, 120 mA., **15 6**; 9 hy. 250 ohm 170 mA., **8 6**; 15 hy. 200 ohm, 250 mA, **26 6**.

I.F. Transformer 465 K/c. New well-known manufacturer's surplus, 2in. × 2in. × 1¼in. Iron Core, **9**/- each and also size 1in. × 1¼in. × 2in. at **12 9** per pair. Each have adjustable Iron Cores. Denco Iron Core, 465 K/c. or 1.6 M/c., 1¼in. × 1¼in. × 3½in., **19 6** pair. New Surplus 465 K/c. Iron Core, 4in. × 1¼in. sq., **10**/- pr.

Transformers. (a) Input 230 volt, output 900 volt 250mA and 6.3 v. 9 amp., **11 9**; (b) Input 230 volts, output 250 volts 30 mA., and 6.3 volts 1 amp., **14 6**.

E.H.T. Transformer. Prim. 230 v. Sec. 2 Kv. and 4-volt tapped 2 volt, **50 6**. Do. but 4 Kv., **54**/-.

Heater Auto Transformers. (a) tapped 2 v. 4 v. 5 v. and 6.3 volts 3 amp., **10 9**; (b) 4 v. 2 amp. to 5 v. 2 amp. Reversible, **7 6**; (c) 4 v. 3 amp. to 6.3 v. 2 amp. Reversible, **7 9**.

Filament Transformer. Inputs 230 volts, outputs 6.3 v. 1½ amp., **8 3**; 4 v. 1½ amp. **7 6**; Input 200/250 v. output 4 v. (C.T.), 1½ amp., 4 v. 2amp., 6.3 v. 2 amp. **13 6**. Input 230 v., output 6.3 v. (C.T.) 4 amp. **17 6**.

Metal Chassis, substantially made with four sides. 7in. × 4in. × 2in., **3 11**; 9" × 5" × 2¼in., **5 3**; 10 × 4 × 2¼in., **5 6**; 10 × 7 × 2¼in., **6 3**; 12 × 9 × 2¼in., **7 9**; 14 × 9 × 2½in., **8 3**; 16 × 8 × 2¼in., **9**/-.

New Mfrs. Surplus Transformers. Input 200 to 240 volts output 12 v. 8 amps., **21**/-.

Mains Transformers. All New Stock with Primaries tapped for 200-250 volts. Secondaries (a) 350-0-350 volt, 80 mA. 6.3 v. (tapped 4 v.) 4 amp. and 5 v. (tapped 4 v.) 2 amp., **32 6** (also available with 350-0-350 volt at **22 6**). Stern's 350-0-350 volt, 150 mA. 6.3 v. (tapped 4 v.), 4 amp. and 5 v. (tapped 4 v.) 2 amp., **41 6**; (c) 350-0-350 v. 250 mA. 4 volt 8 amp., 4 v. 3 amp., 6.3 v. (tapped 2 v.) 2 amp. and 6.3 v. 6 amp., **84**/-, and many other ratings.

Westinghouse Rectifiers. (a) H.T. 51. Rated 350-0-350 volts 100 mA., **35**/-; (b) H.T.52. Rated 350-0-350 v. 200 mA., **37 6**; (c) H.T.53. Rated 500-0-500 v. 200 mA., **50**/-.

Types. 14HT56, **11 3**; 16HT28, **12 6**; 16EHT36, **17 9**; 36EHT35, **13 10**; 36EHT35, **18 2**; 36EHT40, **20 6**; 36EHT45, **22 6**; 36EHT36, **24 10**; 36EHT60, **25 6**; 36EHT100, **28 5**; 36EHT12, **7 9**.

F Wave Bridge Rectifiers:

For charging 2, 4 or 6 volts at 1½ amps.	12 6
For charging 6 or 12 volts at 1½ amps.	13 6
For charging 6 or 12 volts at 3 amps.	21 6
For charging 6 or 12 volts at 5 amps.	25 10
For charging 12 or 24 volts at 3 amps.	25 9

A Variable Resistor for control of Charging Equipment (or Models) up to 3 amps., **17 9**, or for 1½ amps. **15**/-.

Meter Rectifiers. Westinghouse 250 micro-amp., **12 9**. 1 mA., **11 9**; 5 mA., **6 9**.

Sovereign Rectifiers. H.T. 36. Rated 250 v. 50 mA., **6 6**; 250 v. 100 mA., **8 6**; 250 v. 170 mA. **15 6**.

Charger Transformers. A.C. ratings. Suitable for use with preceding Rectifiers. Each has input of 230 volts. Outputs: (a) 24 volts tapped 15 v. 9 v. and 4 v. at 5 amps., **25**/-; (b) 30 volts tapped 15 v. and 9 v. at 5 amps., **26 3**; (c) 15 volts tapped 9 v. at 3 amps., **21**/-; (d) 12 volts 1½ amps., **12 3**; (e) 15 volts tapped 9 v. at 6 amps., **24 3**; 15 volts tapped 9 v. at 1½ amps., **15 9**; 12 volts 1 amp., **7 6**.

A Battery Charger Wiring Diagram is included with purchase of Charger Transformer and Rectifier.

Adjustable Mains Droppers. 1½in. dia. × 2½in. (a) 15 amp. 1,000 ohms, **5**/-; (b) 2 amp. 1,000 ohms, **4 3**; (c) 3 amp. 600 ohms, **5**/-.

Television. We keep a very comprehensive range of T/V components. The Viewmaster T/V Assembly Instructions showing Practical Layout and Price List in stock, price **5 6** (incl. post). We can supply all the specified components for the T/V or stock either by way of individual components or by the published stages.

"O" Max Chassis Cutters. The quickest and most simple method of Chassis cutting consists of a die, punch and Allen screw.

To cut ¾in. dia. (B7G)	11 6
To cut ¾in. dia. (B8a)	11 6
To cut 1in. dia. (Octal)	14 9
To cut 1in. dia. (English)	14 9
To cut 1¼in. dia. (EF50)	16 6
Key for any of above	1 3

The new **Pyrobil Soldering Iron,** with instrument-type tip for use on A.C. or D.C. mains, **24**/-. Spare elements and bits always in stock.

Components and many KITS OF PARTS for both Sets and Battery Chargers.

approx. cost of Post and Packing.

& 115 FLEET STREET, E.C.4

5814 and 2280

CLYDESDALE

Bargains in Ex-Service Radio and Electronic Equipment

CONTROL UNIT TYPE 431. Ref. : 10LB 6037

Contains : Large wirewound potentiometer 3,000 ohms Micro Switch (press for " on "), key switch, 4 make, 4 break, two toggle switches, two 6-way W. plug receptacles. Enclosed in metal box with sloping face panel, cover is attached by 4 dzus studs. Dims. : 6 × 5¼ × 4¼in., finish grey.

CLYDESDALE'S PRICE ONLY **17/6** EACH — CARRIAGE PAID

100 Kc/s CRYSTAL. Type AR21W

Made by Bliley of U.S.A.

Upright Mtg. Dims. : 1¼ × 1¼ × 1¼in., 3-pin plug

CLYDESDALE'S PRICE ONLY **19/6** EACH — POST PAID

DYNAMOTOR PS.225

Made by Pioneer Gen-E-Motor of U.S.A.

Input: 14 volts 8.5 amps. Output: 375 volts 0.15 amps. R.P.M.: 4,500 continuous duty. Size: 6¼in. long by 3¼in. diameter. With smoothing and filters in box. Size: 6¼ × 4¼ × 7¼in. attached.

CLYDESDALE'S PRICE ONLY **37/6** EACH — CARRIAGE PAID

DOUBLE COIL RELAY

Single make contact with adjustable screws. Coil of 300 ohm resistance operates at 9 volts. 10ms. 1¼ × 1in. dia. Coils of 0.1 ohm resistance operates at 1.3 volts. 10ms. 1½ × 1in. dia. Overall dimensions (excluding coil diameters) 2 × 1¾in.

CLYDESDALE'S PRICE ONLY **4/6** EACH — POST 9d.

DAY AND NIGHT SIGNAL LAMP

Consists of a Morse Key mounted on a metal box 8¼ × 8¼ × 8¼in. which holds a battery and lamp. The lamp is 4in. dia. has a glass covered mirror lens throwing a long narrow beam. Mounted on top of the lamp is a sighting tube to align signals on the reception point. The lamp can be held in the hand or mounted on a telescopic earth spike which extends from 7ft to 20ft.

For night signalling an adjustable screen is provided with 3 coloured discs to reduce light intensity.

Complete with 3 bulbs, fuse wire, spare plugs and parts, earth spike, web carrying strap, test lamp with spare bulb, and green, amber and red discs.

CLYDESDALE'S PRICE ONLY **27/6** EACH — CARRIAGE PAID

CRYSTAL RECEIVER

With Variometer Tuning, Double Crystal Detector, provision for 3 sets of headphones. Housed in round Plastic case 4¼in. dia. by 7in. high. Unused, but have been in store for some time, the terminals may need tightening.

CLYDESDALE'S PRICE ONLY **15/-** EACH — POST PAID

WIRELESS REMOTE CONTROL UNIT D No. 2 MK. 2. ZA23491

Consists of a wooden box 7¾ × 8¾ × 3¼in. with hinged lid, containing three relays 1 of 1 make with 500 ohms coil 1 of 1 make with 20 ohms coil, and heavy duty contacts, 1 of double coil type, 1,750 ohms coil makes, 500 ohms coil breaks with QMB switch and 8 brass terminals.

CLYDESDALE'S PRICE ONLY **14/6** EACH — POST PAID

TRANSFORMER. Type 110k 164

Made by United Transformer Corp. of New York.

Small auto transformer winding resistance 500 ohms tapped at 40 ohms. Ratio 5.5-1, in metal case, size 2¾ × 2¼ × 2in., two hole fixing.

CLYDESDALE'S PRICE ONLY **3/6** EACH — POST 9d.

OUTPUT LOUDSPEAKER TRANSFORMER

Primary : 2,500 ohms with terminal board.
Secondary : 2 ohms, size 2¾ × 1¾in.

CLYDESDALE'S PRICE ONLY **4/-** EACH — POST 9d.

SMALL L.F. CHOKE

30 Henries 50 mA. 400 ohms.
Size : 2¾ × 2in.

CLYDESDALE'S PRICE ONLY **4/-** EACH — POST 9d.

SCR-522

This famous Transmitter/Receiver frequencies 100-156 mc/s with valves.
Comprises : BC-624 Receiver 10 valves. BC-625 Transmitter 8 valves.
Can be converted to cover 144 mc/s Amateur Band, used, but in good condition.

CLYDESDALE'S PRICE ONLY **£20.10.0** CARRIAGE PAID

P.E.-73-C Power Unit for the BC-357

Input : 28 volts D.C. 19 amps. Output : 1,000 volts D.C. 0.35 amps. 3,000 r.p.m. 0.35 KVA 500 ~.
Suppressed for Radio use. Dims. Overall length 10¾in. dia. 6¼in. complete with fuse panel and starter.

CLYDESDALE'S PRICE ONLY **£2.15.0** EACH — CARRIAGE PAID

Large and varied selection of books on Radio and Television always available, also circuits of Ex-Service Units.

I.F.F. CONTROL UNIT. TYPE 90. 10LB 91

Contains
7-way Belling & Lee Socket (Chassis Mtg.).
7-pin Belling & Lee Plug (Chassis Mtg.).
5-way Belling & Lee Socket (Chassis Mtg.).
5-pin Belling & Lee Plug (Chassis Mtg.).
4-way P.O. Telephone Socket (Large Pattern).
6-way Single Wafer Switch.
Arrow Slide Action Switch.
On/Off switch.
Unit is made in two boxes attached together.
Size: 7 × 4 × 3½in. and 4½ × 2 × 3in.

CLYDESDALE'S PRICE ONLY **5/6** EACH — POST 9d.

NEW LIST OF EX-SERVICE and other Items No. 88. Price 1/6. Price credited on first purchase of 10/- value or over.

DYNAMOTOR TYPE DSX-12

By Pioneer Gen-E-Motor U.S.A.

Input: 12.7 volts D.C. 17 amps. Output: 250 volts D.C. 0.06 amps. R.P.M.: 6,300 continuous, fully enclosed. Size: 4¼in. long, 2¾in. dia.

CLYDESDALE'S PRICE ONLY **35/-** EACH — POST PAID

DYNAMOTOR TYPE DSX-12

By Pioneer Gen-E-Motor U.S.A.

Input: 27 volts D.C. 1.75 amps. Output: 250 volts D.C. 0.06 amps. R.P.M.: 6,300 continuous, fully enclosed. Size: 4¼in. long, 2¾in. dia.

CLYDESDALE'S PRICE ONLY **19/6** EACH — POST PAID

U.S.A. METAL (MINE) DETECTOR. BC-625-A

Indicates metal by both sound and sight.
Comprising BC-1141-C 5 valve amplifier, valves 2/1R5's, 1G-6 in canvas carrying case. Exploring assembly, consists of Search Coil, handle, headphones and Control Box containing Visual Indicator, test button, compensator and on-off switch, batteries (NOT SUPPLIED). L.T. 1.5 volts, H.T. 90-100 volts. The whole contained in Chest CH.158 a strong wooden suitcase type box, with metal handle, size 37½ × 14¾ × 9¾in. Used, good condition.

CLYDESDALE'S PRICE ONLY **£10.0.0** EACH — CARRIAGE PAID

NITROGEN BOTTLE AND PRESSURE GAUGE 2,000 lb.

Size of bottle 13in. long, 3in. dia. Size of gauge 1¼in. deep, 2¼in. dia. Unused but slightly soiled through storage.

CLYDESDALE'S PRICE ONLY **15/-** EACH — CARRIAGE PAID

TELEPHONE EXCHANGE. 10 line type

Complete with Handset and 10 cords fitted with jackplugs each end and weights could be used with Tele F or other Field Telephones.

CLYDESDALE'S PRICE ONLY **£10.0.0** EACH — CARRIAGE PAID

DYNAMOTOR TYPE DM

For RL-3 Interphone Amplifier. Would suit SCR-224 Command Receivers having the same fitting and dimensions by Sound Equipment Corp. of California.

Input: 28 volts D.C. 1.25 amps. Output: 250 volts D.C. 0.06 amps. Fully enclosed, size 4¼in. long, 2¾in. dia., with 3-way socket.

CLYDESDALE'S PRICE ONLY **30/-** EACH — POST PAID

POWER UNIT TYPE 2A. 10K 44 for the TR 1133

Input: 12 volts D.C. 16.5 amps. Outputs: 6 volts D.C. 5 amps. 150 volts D.C. 10 mA. 300 volts D.C. 70/240 mA. With starting relay, LT and HT Smoothing chokes and condensers, etc., input and output brought to 10 pin Jones type chassis plug. In metal case, size: 12¾ × 8 × 8¼in., finish black.

CLYDESDALE'S PRICE ONLY **42/-** EACH — CARRIAGE PAID

TEST SET IE-36. For SCR-522.

Comprising: Chest CH-524 containing Control Unit BC-1302, Antenna A-29 Cords, CD-1169, CD-1170, adjustable spanner wrench (Bendix), Lamp Extractor (Bendix). In original Makers Carton.

CLYDESDALE'S PRICE ONLY **£5.0.0** EACH — CARRIAGE PAID

INFRA-RED IMAGE CONVERTER CELL

CLYDESDALE'S PRICE ONLY **15/-** POST PAID

R-27 ARC-5 or CCT 46106

In original Makers Carton.

A 6-valve Receiver of the Command Series, AN/ARC-5-SCR-274-N. Ranges 6-9.1 mc/s I.F. 2830 Kc/s. Valve line-up 2/12SK7, 12K8, 12SF7 or 12SK7, 12SR7, 12A6. In black metal case. Dimens. 15 × 9¼ × 10in. Less Dynamotor.

CLYDESDALE'S PRICE ONLY **£4.10.0** EACH — POST PAID

HYDRAULIC PUMP

Made in U.S.A.

Input: 24 volts D.C. 10 amp. Cap. 24 galls per min. 600 lbs. per sq in. Intermittent operation. Dim.: 13 × 6 × 9in.

CLYDESDALE'S PRICE ONLY **52/6** EACH — CARRIAGE PAID

ANTENNA SWITCH SA-4A APA-1

Comprising 24 volt D.C. 0.5 amp. motor, vertically mounted, driving 2 pole 2-way switch. Housed in black crackle finish metal box. Size: 7¾ × 3¼ × 5¼in. Leads from the motor are brought to on-axial sockets on the front panel, on which is also mounted a 2-pin mains socket, 2 screw-in type fuse-holders and mains toggle switch, with safety cover.

CLYDESDALE'S PRICE ONLY **21/-** EACH — POST PAID

CALIBRATOR UNIT RDF No. 1. ZA.14401

In original wood case. Containing 2, VR65 (SP61), 2 VR66 (P61), 2 VR92 (EA50), 5Z4G, VGT 108 (GT1C), plus smoothing and other condensers, resistors etc. High cycle power supply on metal chassis, 12 × 7¼ × 9¼in., with cover.

CLYDESDALE'S PRICE ONLY **39/6** EACH — CARRIAGE PAID

POWER UNIT FOR WS-38-AFV.

Vibrator Power Unit for 12 volt D.C. Input containing Metal Rectifier, Output valve ATP4 (VT248A), Condensers, Resistors, etc. In metal case, 11¼ × 6 × 6in. All leads brought to a 12-pin Chassis Plug on front panel.

CLYDESDALE'S PRICE ONLY **35/-** EACH — POST PAID

MOVING COIL MIC HEADPHONE ASSEMBLY

M.C. Headphones have padded earpieces. Microphone is Handset No. 7 with leads terminated in 5-way rubber socket (tank style). Brand new. Boxed.

CLYDESDALE'S PRICE ONLY **25/-** POST PAID

TEL-REC HANDSET NO. 9 ASSEMBLY

M.C. Headphones fitted with rubber earpieces. Microphone is Carbon, Power type, with leads terminated in 5-way rubber socket (tank style). Brand new. Boxed.

CLYDESDALE'S PRICE ONLY **25/-** POST PAID

LOW IMPEDANCE HEADPHONES DLR-1

With metal strap headbands, lead and jack plug. Brand new. Boxed. Resistance approx. 50 ohms.

CLYDESDALE'S PRICE ONLY **12/6** PER PAIR — POST PAID

HIGH IMPEDANCE HEADPHONES

CHR-2 with wire headband and canvas neckstrap, resistance 4,000 ohms. Brand new. Boxed.

CLYDESDALE'S PRICE ONLY **21/-** PER PAIR — POST PAID

THROAT MICROPHONES

Pair electro-magnetic throat pieces (7.5 ohms each) with strap, lead and jack plug. Ref. ZA13935.

CLYDESDALE'S PRICE ONLY **5/6** PER PAIR — POST 6d.

FLUXMETER WY.0023

Designed to calibrate the field of Magnets within the range of 500 to 4,000 gauss and to determine their polarity. Complete with probe unit and contained in a hardwood case with hinged lid and handle. Instructions on lid. Dimensions 12¾ × 9 × 6in.

CLYDESDALE'S PRICE ONLY **£7.10.0** CARRIAGE PAID

TEST KIT, TYPE 6. Ref. 10S 720

For testing APN-1 Radio Altimeter Equipment. Comprising the Radio Altimeter F.M. Oscillator operating on 420 mc/s. British version using mostly American Components including 1,000 ohm potentiometer, 5 watt wire wound resistors. Complete with Dynamotor for 24 v. D.C. operation (recess for alternative 60 v. and 1.5 v. batteries). In metal carrying case with handles and hinged lid, 18 × 12 × 10¼in.

CLYDESDALE'S PRICE ONLY **£6.19.6** CARRIAGE PAID

VHF CONTROL PANEL TYPE 3A

Contains numerous induction and retardation coils, relays, ringing generator, key switches etc. etc. Dim.: 19 × 11 × 9in.

CLYDESDALE'S PRICE ONLY **65/-** CARRIAGE PAID

Order direct from

CLYDESDALE SUPPLY CO. LTD. 2 BRIDGE STREET GLASGOW · C5

Phone : South 2706/9 — Branches in Scotland, England and Northern Ireland

HENRY'S

5 Harrow Road, Paddington, W.2

PADdington 1008/9 and 0401

E.H.T. TRANSFORMER for VCR97. Input 230 v., output 2,500 v. 4 v. 2-0-2. **45/-**.
E.H.T. TRANSFORMER for 5CP1. Input 230 v. output 3,250 v. at 0.6 a.m. 2-0-2 v., **45/-**.
"HIGH-VOLT" R.F. OSCILLATOR. S-7 Kv. at 250 m.a., **£5 10 3**; 12.5 Kv. at 250 m.a., **£10 10/-**.
CONDENSERS. .1 mfd. 2,500 v.w., metal or bakelite, **2/6** Electrolytics, 8 mfd. 450 v.w., **2/6**. 8 x 8 mfd., **4/-**; 16 mfd. 450 v.w., **3/6**; 16 x 16 mfd. 450 v.w., **5/-**. All midget Tubular Cans, cardboard sleeves. 60 mfd. x 40 mfd. 350 v.w., size 4¼in. x 1in., **7/6**. Bias Condensers, 25 x 25 mfd., 50 x 12, 12 x 50, **1/6**; 50 x 50, **3/-**. All new stocks—NOT surplus.
CONDENSERS—TUNING. 2-gang .0005 standard ¼ spindle, **5/-**; 2-gang .0005 standard trimmers, **7/6**; 3-gang .0005 with ceramic insulation, ¼ spindle, **7/6**; 4-gang .0005 with ceramic insulation, ¼ spindle, **5/-**. MIDGET .0005 mfd. 2-GANG TUNING CONDENSER. Size only 2¼ x 1¾ x 1¼in., **6/6**; or with built-in trimmers, **7/6**. TWO-GANG MIDGET .0005 with 4-way push-button assembly. Suitable for car radio, etc., **8/6**. 2-gang midget, .0001 ceramic insulation, **5/6**. Single solid dielectric tuning condensers, .0001, 0.0003 and 0.0005 J.B., **3/6**.
MAINS TRANSFORMERS. 250-0-250, 90 m.a., 6.3 v. 3 amp., 5 v. 2 amp., input 110 v. 250 v., **£1**, post 9d.
EX-MANUFACTURERS. 350-0-350, 100 m.a., 6.3 v. 4 amp., 5 v. 2 amp., input 200/250, **25/-**.
REPLACEMENT TYPE. 350-0-350, 90 m.a. 4 v. 6 amps., 4 v. 3 amps., input 200/250, **10/6**.
DUAL PURPOSE TYPE. 350-0-350 80 m.a., 6.3 v. tapped 4 v. at 3 amps., 5 v. tapped at 2 amps., 4 v. **20/-** (post 9d.).
WALKIE-TALKIE TYPE "46" complete with 6 valves. 2VP23, HL23, DD, QP25, TP25 and ATP4, aerial rods, I.F. trans., 1.6 mc/s. mike trans. in new condition, but less transmitting components and coils removed by M.O.S., **35/-**, carr. paid.

BOWTHORPE CONTINUITY METER. Dual scale 0-500 ohms and 100-200,000 ohms moving coil operated from 4½-volt internal battery. Size 6in. x 3in. x 4in. Original price **£8 19/-**. Our price, brand new, **£4 4/-**.

CATHODE RAY TUBES

VCR97 Brand New. Guaranteed full picture, carriage paid	£2 5 0
VCR139A Brand New. Suitable for 'scopes, carriage paid	£1 15 0
3BP1 Brand New. Suitable for 'scopes, carriage paid	£1 5 0

9in. ESCUTCHEON. Brown bakelite. Suitable plate glass and mask for 9in. tube. Price **7/6** each.

MOVING COIL METERS (Brand New)

0-5 m.a. square panel mounting 2in. scale	7/6
0-50 m.a. sq. panel mounting, 2in. scale	7/6
0-40 v. square panel mounting	7/6
0-20 amps square panel mounting	7/6
0-300 v. square panel mounting	12/6
0-40/120 m.a. double reading round scale	12/6
0-100 v. A.C. rectified type 2½in. round scale	£1 5 0

2½in. Round flush mtg. drilled flange.
Range 0/750 volts, 200 ohms per volt each **£1 2/6**
Range 0/1500 volts, 250 ohms, per volt ea. **£1 2/6**
Range 0/3000 volts, 200 ohms, per volt ea. **£1 5/-**.

RECEIVER UNIT TYPE 159. Size 8in. x 6½in. x 4½in. containing VR91, VR92, CV66, VR65 and 24 v. selector switch. New condition **15/-**.

OSCILLOSCOPE TYPE 3BP1. We have pleasure in offering a 'scope designed primarily for simplicity and low cost at the same time giving reliable and consistent results. The Service engineer will find this an invaluable instrument due to its compactness, simplicity and speed of interpreting faults in radio receivers, checking transmitters, modulation, depth, etc.

SPECIFICATIONS:

Amplifier: Max. Gain, Peak to Peak — .3 volts per cm. Frequency response 10 c/s—100 k/c. Flat — 100 c/s to 50 k/c. Time Base: frequency range 5 c/s—30 k/c.

Dimensions: 8½ x 6½ x 11½. Weight 17½ lb. Black crackle finish.

Price: Brand New, **£14 14/-**, carr. pd.

GERMANIUM CRYSTAL DIODES, complete with full wiring circuit and diagram, **4/6**.

METAL RECTIFIERS

S.T.C. 300 volts 75 m.a.	6/8
S.T.C. R.M.2. 150 volt 120 m.a.	4/6
G.E.C. 6 volt 1 amp.	4/9
Westinghouse 12 volt 2½ amp.	12/6
S.T.C. 12 v. 3½ amp.	17/6
E.H.T. Pencil Type, 600 volt 1 m.a.	4/7
E.H.T. Pencil Type, 1,000 volt 1 m/a.	6/8
G.E.C. 1 m.a. Meter Rectifier	11/6

PUSH-PULL OUTPUT TRANSFORMER, U.S.A. potted type primary, 10,000 ohms. sec., 2 ohms, 8 ohms, 15 watts, **21/-**.

PYE 45 Mc/s STRIP
Special purchase of M.O.S. Type 3583 Unit, size 15in. x 8in. x 2in. Complete with 45 mc/s Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls and host of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum of space. New condition. Price **£5**, carriage paid.

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This Unit contains VCR 517 Cathode Ray 6in. Tube, complete with Mu-Metal screen, 3 EF50, 6 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of Television (full picture guaranteed) or Oscilloscope. Offered BRAND NEW (less relay) in original packing case at **79/6**. Plus 7/6 carriage.

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705 Coil Pack 3 wave band	£1 17 10
400B Min. I.F.T. 465, pair	15 0
501 and 502, 465, pair	14 0
800's pair	15 0

SPECIAL PURPOSE VALVES
VR91 (EF50). Brand new Sylvanian Red in original cartons, **10/-**. VR91 (EF50). Brand new British types in original cartons **8/6**. VR91 (EF50). Ex-units. As new and guaranteed **6/-**. 813 at **£5**. TZ 40 at **37/6**. VR/150/30 and VR105/30 at **8/6**. 810 at **£2**. U19 **10/-**. 7475 (VS70) **8/6**. PX25 **10/-**. We have over 10,000 British and American valves in stock send for lists.

CAR RADIO COMPONENTS

Vibrators, 6 or 12 volt, 4 pin	5/-
" 6 volt 6 Pin Synchronous type	12/6
" 24 volt 4 Pin	7/6
" 2 volt 7 Pin	7/6
" Trans. 6 volt, 180 v. 40 m.a.	9/6
" Trans. 6 volt, 250 v. 60 m.a.	10/-

RECEIVER R.1355.—As specified for "Inexpensive Television." Complete with 8 valves VR65 and 1 each 5U4G, VU120, VR92, only **45/-**, carriage 7/6.

R.3515 I.F. STRIP. A complete I.F. Unit, comprising 6 SP61 I.F. Stages, tuned to 13.5 Mc/s., 1 EA50 diode detector, and 1 EF36 or EF39 output or video stage. A few modifications only are required to adapt this unit, which will give pictures of extremely good quality. Price, complete with valves, and foolproof modification instructions, is **45/-**, plus 5/- carriage and packing. Limited quantity only.

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Input 6 v., Output 200 v., 40 m/a.	25/-
Input 12 v., output 180 v., 40 m.a.	30/-
Input 2 v., output 180 v./90 v., 35 m/a., 1.4 v., 250 m.a.	50/-
Input 6 v., Output 180 v. 40 m.a., for 2½ sec	17/6

All units completely smoothed.

TRANSFORMERS—FILAMENT. All inputs 200/250 v. A.C.

Output 6.3 volts 1.5 amps.	7/6
Output 6.3 volts 2.5 amps.	10/-
Output 6 and 12 volts 3 amps.	£1/-/-
Output 6.3 volts, 12 amps.	£1 5/-
Output 12 and 24 volts 6 amps.	£2 2/-

N.B.—Above voltages are when "on load."

No. 38 "WALKIE TALKIE" TRANSRECEIVER, complete with throat mike, 'phones, junction box and aerial rods in canvas bag. Freq. range 7.4 to 9 Mc/s. All units are as new and tested before dispatch. As supplied to Overseas police forces. **£4 19/6**, carr. 2/6.

A COMBINED SIGNAL TRACER AND AUDIO OSCILLATOR.
An easy-to-build unit that can be used for I.F. and Audio Signal Tracing, without any switching or tuning, including variable output oscillator for amplifier checking. Highly sensitive, responds to signals picked up from an ordinary receiving aerial.

The circuit is that of a high-gain 2-stage, resistance-coupled audio frequency amplifier, employing 3 miniature 1.4 valves, with a 3in. speaker in the Output of the Power Amplifier Stage. An added advantage being that as this unit is "All-Dry" it can be used with safety on A.C. or A.C./D.C. mains and battery sets. The complete kit with portable cabinet (size 6in. x 7in. x 6in.) and battery weighs only 4 lb.

We shall be pleased to supply a complete kit for the construction of the above, right down to the last nut and bolt, including 2 1T4 and 1 1S4 valves, 3in. speaker and portable case and all-dry battery for **£4 19/6**. Concise instructions and circuits supplied. If preferred, circuit and instructions only can be supplied for **1/6**. If required this unit will be assembled and tested for extra charge of **15/-**. This is a highly efficient instrument, and a MUST for every radio man.

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Fully Guaranteed, Interleaved, and Impregnated. Primaries 200-230-250 v. 50 c/s. Screened.

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240-0-240 v. 80 ma., 6.3 v. 2 a., 5 v. 2 a. 15/9
350-0-350 v. 80 ma., 6.3 v. 2 a., 5 v. 2 a. 17/6
350-0-350 v. 90 ma., 6.3 v. 3 a., 5 v. 2 a. 21/9
250-0-250 v. 100 ma., 6.3 v. 4 a., 5 v. 3 a. 23/11
300-0-300 v. 100 ma., 6.3 v.-4 v. 4 a. C.T. 0-4-5 v. 3 a. 23/11
350-0-350 v. 100 ma., 6.3 v.-4 v. 4 a. C.T. 0-4-5 v. 3 a. 23/11
350-0-350 v. 120 ma., 6.3 v. 4 a., 5 v. 3 a. 28/11
350-0-350 v. 150 ma., 6.3 v. 4 a., 5 v. 3 a. 29/11

CLAMPED UPRIGHT MOUNTING

250-0-250 v. 100 ma., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion 26/9
350-0-350 v. 100 ma., 6.3 v. 3 a., 5 v. 3 a. 23/10

FULLY SHROUDED UPRIGHT

250-0-250 v. 60 ma., 6.3 v. 2 a., 5 v. 2 a. Midget type 2½-3-3in. 17/9
250-0-250 v. 100 ma., 6.3 v.-4 v. 4 a. C.T. 0-4-5 v. 3 a. 25/9
300-0-300 v. 100 ma. C-4-6.3 v. 4 a., 0-4-5 v. 3 a. 25/9
350-0-350 v. 70 ma., 6.3 v. 2 a., 5 v. 2 a. 18/9
350-0-350 v. 100 ma., 6.3 v.-4 v. 4 a., 0-4-5 v. 3 a. 25/9
350-0-350 v. 150 ma., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. 33/9
350-0-350 v. 150 ma., 6.3 v. 4 a., 5 v. 3 a. 33/9
350-0-350 v. 250 ma., 6.3 v. 6 a., 4 v. 8 a. 0-2-6 v. 2 a., 4 v. 3 a., for Electronic Eng. Televisor 67/6
425-0-425 v. 200 ma., 6.3 v.-4 v. 4 a. C.T. 6.3 v.-4 v. 4 a., C.T., 0-4-5 v. 3 a., suitable Williamson Amplifier etc. 51/-
325-0-325 v. 20 ma., 6.3 v. 0-5 a., 6.3 v. 1.5 a. for Williamson Preamplifier 17/6

FILAMENT TRANSFORMERS

All with 200-250 v. 50 c/s., primaries: 6.3 v. 2 a., 7/6; 0-4-6.3 v. 2 a., 7/9; 12 v. 1 a. 7/11; 6.3 v. 3 a., 10/11; 6.3 v. 6 a., 17/9; 0-2-4-5-6.3 v. 4 a., 16/9; 12 v. 3 a., or 24 v. 1.5 a. 17/9

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All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., 13/9; 0-9-15 v. 3 a., 16/9; 0-9-15 v. 6 a., 22/9; 0-4-9-15-24 v. 3 a., 22/9; 0-9-15-30 v. 3 a. 23/9

SMOOTHING CHOKES

250 ma., 8-10 h., weight 12 lb. 17/6
200 ma. 5 h. 100 ohms 7/6
100 ma. 10 h. 100 ohms 7/6
80 ma. 10 h. 350 ohms 5/6
60 ma. 10 h. 350 ohms 5/3

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 ma 7/11
120-0-120 v. 30 ma., 4 v., 1 a. 12/9

OUTPUT TRANSFORMERS

Midget Battery, Pentode 66 : 1 for 354, etc. 3/6
Small Pentode, 5,000 ohms to 3 ohms 3/9
Standard Pentode 5,000 ohms to 3 ohms 4/9
Multi ratio 40 ma., 30 : 1, 45 : 1, 60 : 1, 90 : 1 Class B Push-Pull 5/6
Push-pull 10-12 watts 6V6 to 3 or 15 ohms 15/11
Push-pull 10-12 watts to match 6L6, PX4, 6V6, etc., to 3-5-8 or 15 ohms speaker 16/11
Push-pull 15-18 watts to match 6L6, etc., to 3 or 15 ohms speaker 22/9

P.M. SPEAKERS. All 2-3 ohms: 5in. 11/9; 6in. 14/11; 8in. 14/11. 10in. Goodmans 27/9.

M.E. SPEAKERS: 8in. 3 ohms, field 600 ohms 12/9. 10in. 3 ohm (field 1,000 ohms). 21/9.

VOLUME CONTROLS, with long spindles. All values less switch, 2/9; with S.P. switch, 3/11.

WIRE WOUND POTS., 20 ohms, 750 ohms, 5K, 20K, 50K, 2/9.

ELECTROLYTICS. Tubular, 8 mfd. 350 v., 1/9; 8 mfd. 450 v., 1/11; 16 mfd. 350 v., 2/3; can 16 mfd. 450 v., 2/11; 24 mfd. 350 v., 2/11; 8-8 mfd. 450 v., 8-16 mfd. 450 v., 4/6; 16-16 mfd. 450 v., 5/3; 32 mfd. 350 v., 4/3; 32 mfd. 450 v., 5/3; 40 mfd. 450 v., 4/9; 32-32 mfd. 350 v., 5/6; 32-32 mfd. 450 v., 6/9; 12-12 mfd. 350 v., 3/3; 250 mfd. 12 v., 11d.

COLLARO RECORD CHANGERS. Latest 3 speed type, complete with Crystal Pick-up, type 3RC511 £11/11/0, plus carr., 5/-.

SPECIAL OFFERS. Fil. Trans. 220/240 v. input, 6.3 v. 1.5 a. output. 5/9. Output Trans. 5,000 to 3 ohms (standard). 3/9; 2 gang .0005 mfd. Variables, 5/3. R1355 Receivers, slightly store soiled, £2 19/6, plus carr. 7/6.

RECEIVER CHASSIS, 16 s.w.g. Undrilled Aluminium 10-5½-2in., 3/9; 11-6-2½in., 4/3; 12-8-2½in., 5/3; 16-8-2½in., 8/6; 20-8-2½in., 9/11.

AMPLIFIER CHASSIS, 16 s.w.g. Undrilled Aluminium, 12-8-2½in. 7/11; 16-8-2½in., 10/11; 20-8-2½in., 13/9.

MISC. ITEMS. Philips chokes 90 ma. 8 h. 100 ohms 4/6; TRF coils L. and M. with circuit 6/6; 4-pole 4-way Yaxleys L/S, 1/11. Ex-Gov. Chokes (Trop.), 50 ma. 50 h. 1,000 ohms, 4/6. VR91 Ex. New Equipment, 6/6.

SELENIUM RECTIFIERS. Ex-new equipment. 230 v. 50 ma. H.W., 4/9; 120 v. 40 ma., 2/9. New Bridge type, F.W. 12 v. 2½ a., 13/11; 12 v. 4 a., 18/11.

FULL RANGE OF STANDARD COMPONENTS AVAILABLE AT KEEN PRICES. ALL GOODS GUARANTEED AND NEW, UNLESS OTHERWISE STATED. QUANTITY QUOTATIONS GIVEN FOR STANDARD TYPES OR SPECIAL MAINS TRANS. S.A.E. PLEASE WITH ALL ENQUIRIES. FULL STOCK LIST 4d. SPECIAL LIST FOR TRADE, 4d.

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HIGH RESISTANCE HEADPHONES. Ericsson's first grade, 4,000 ohms per pair, brand new, boxed, 17/6.

LOW RESISTANCE 'PHONES, 5/11.

RECEIVER P40. Complete with valves, tuning 85-95 mc/s., these are ideal for Wrotham or "2" metre conversion. Housed in attractive robust grey cases these contain 4 EF54s (RF, mixer, Xtal multipliers), EC32 (Xtal oscillator), 2 EF39s (2.9 mc/s IFs), EB34 (det), 6J5 and 6V6 (audio). In original cartons, complete with circuit, 69/6, Post 1/6.

TRANSMITTER 21. Sending CW, MCW or speech on 4.2—7.5 and 18—31 mc/s these are complete with valves, circuit, control box, key and front panel. Wire (not formers) from PA coils, and relays, have been stripped by the M.O.S. but may easily be replaced with the aid of our circuit and data. In excellent condition, 25/-.

POWER UNIT S441B. With separate individually controlled HT and LT transformers, jewelled indicator lights, attractive appearance, modest size (14in. x 7½in. x 7in.) these delivering 300 v. at 200 mA., fully smoothed, 12 v. at 3A, AC and 5 v. DC, from 200/250 v. 50 cps. In ORIGINAL CARTONS. Only 65/- (carr. 5/-).

VIBRATOR UNIT 21. 6 v. input, approx. 160 v. at 40 mA. smoothed DC output; designed for the Tx/Rx 21. In new condition. ONLY 17/6.

BRAND NEW ACCUMULATORS in transparent, unspillable plastic cases. 7 A.H. 2 v., 6/6.

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NEW 1355 CONVERSION data for all 5 TV channels, 3/-.

MIDGET AMPLIFIERS with two 12SH7s, one 12SJ7, these measure 5in. x 3½in. x 3in. OUR PRICE 15/-.

H.T. BATTERIES. 60 v., 8/6 each.

HEMISPHERICAL CARBON MICROPHONES, with switch, new, boxed, 5/-.

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AVO Electronic Testmeter. As new, **£30.** Wide Range Signal Generator. Perfect condition, **£25.** Model 7. In new condition, **£15 10.** D.C. Avominor. Ex W.D. New in case, **£4 15/-.** **GS6** Wavemeter. 15 kc/s. to 24 Mc/s. In good condition, **£12 10.** **ADVANCE** Signal Generator E.2. In perfect condition, **£20.** **COSSOR** Double Beam Oscilloscopes. In good condition, from **£30.** **HICKOK** Signal Generator, Model 188X. 100 kc/s. to 100 Mc/s. Output meter. Perfect. **£35.** **MEISSNER** Signal Shifter with coils. In good condition, **£20.** **U.S.A.** Valve Tester, I-177 with charts. Perfect order, **£14.**

BC221 Frequency Meters, TS69AP, Cavity Wavemeters, TS184 Echo box for 400 Mc/s and many other types of high grade lab. gear. 3 and 10cm.—wave guides & wavemeters, RF heads, Directional couplers—U.S.A. naval types

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Loads of other gear—Test Sets, Frequency Meters, Receivers, Sound Equipment, Tape Recorders, etc. All inquiries promptly attended to. S.A.E. please.

We wish to purchase Receivers, Test Equipment, APR4 Units, TS47, TS174, TS175, etc. BC221, S27, CA Receivers, 3 cm. equipment.

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MAINS TRANSFORMERS

These transformers are all famous radio manufacturers' surplus and are fully interleaved, impregnated and guaranteed.

Primary 200-250 v. P. & P. on each, 1/6 extra.

350-0-350, 100 mA., 4 v. 4 amp., 4 v. 2 amp., upright or drop-through, 16/-.

300-0-300, 100 mA., 6 volt 3 amp., 5 volt 2 amp., 17/6.

280-0-280, 80 mA., 6 v. 3 amp., 4 v. 2 amp., drop-through, 14/-.

Drop thro', 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., 14/6.

280-0-280, semi-shrouded drop-through, 80 mA., 6 v. 3 amp., 5 v. 2 amp., 16/6.

Semi-shrouded, drop-thro', 280-0-280, 80 mA, 4 v. 6 amp., 4 v. 2 amp., 12/6.

Auto-wound, H.T. 280 volts at 360 m/a., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separate 4 v. 3 amp. rectifier winding (upright or drop-through), 10/6.

350-0-350, 120 m/a., 4 v. 4 amp., 4 v. 3 amp., drop-through, 21/-.

Auto-transformer, various combinations of voltages including 110 v. 70 watts, and 3-4 volt windings at 1 amp., 2 volt 1 amp., drop-through or upright mounting, 10/6.

Mains Transformer by famous manufacturer. Primary input 230 v. Secondary 220-0-220, 35 m/A L.T. 9 v. 0.75 amp. Size 3½ x 2½ x 1in., fully interleaved and impregnated. Weight 2½lbs. 8/6 post paid.

250-0-250 60 mA, 6 v. 3 amp., 12/6.
250-0-250 80 mA, 6 v. 4 amp., 14/-.

Heater Transformer. Pri. 230-250 v., 6 v. 1½ amp., 6/- ; 2 v. 2½ amp., 5/-. P. & P. each 9d.

P.M. SPEAKERS

	with trans.	less trans.
2½in.	—	13/6
3½in.	—	11/6
5in.	15/-	11/6
6½in.	14/6	11/6
8in.	17/-	13/6

10in., 16/-, less trans.
P. & P. on each of the above 1/- extra.

R. & A. 8in. M.E. Speaker field coil, 1,600 ohms O.P. trans. 5,000 ohms. impedance, 18/6, post and packing 2/-. Rola 5in. with O.P. trans., 16/6.

6½in. energised Telephone Speaker by PLESSEY. Field resistance 68 ohms with humbucking coil. Will pass up to 300 mA., require minimum 200 mA. to energise. These are cheaper than a T.V. choke. 9/6 each. 2 for 18/-.

Constructor's Parcel, comprising chassis 8½ x 3½ x 1½in., with speaker and valve holder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium iron-cored, four valve holders, 20K. volume control and wave-change switch. Post paid, 21/-.

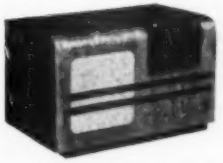
Volume Controls, by famous manufacturer. Long spindle less switch, 50K., 500K., 1 meg., 2/6 each. P. & P. 3d. each.

AMPLIFIER CHASSIS, 18 gauge aluminium, 5 valve holders, transformer and 2 electrolytic cut-outs, size 11½ x 7½in., sloping front, 4/- each.

D. COHEN

RADIO & TELEVISION COMPONENTS

POLISHED WALNUT CABINET. Size 18 x 13 x 8½in. approx., complete with three wave band scale, size 12½ x 4in., scale pan, cadmium plated 5 valve superhet chassis with transformer, valve holder, and I.F. cut-outs size 14 x 6½ x 2½in., drum and back 35/-, post paid. Knobs not supplied.



RADIO CABINETS. In polished walnut size 19 x 11 x 8in. approx., complete with scale. These are slightly soiled and require re-touching. 15/- each, post paid.

CONSTRUCTOR'S POLISHED CABINET. Size 10 x 6½ x 5in. approx., supplied in flatted form, grooved and ready to glue together. Complete with plastic front, 5 valve chassis, cadmium plated, size 8½ x 4 x 1½in., tuning scale, knob and back. Illustration as it would look when assembled. Two bottom knobs not supplied, 10/-, plus 1/6 post and packing.

CONSTRUCTOR'S PARCEL comprising 5-valve superhet chassis with I.F. and electrolytic cut-outs, size 13 x 6½ x 2½in., complete with 3-wave band scale (new wavelengths), size 11½ x 4½in. approx., drum, drive spindle, back plate, two pulley wheels and five International Octal Paxolin valve holders, 11/6 post paid.

MAINS or BATTERY SUPERHET PORTABLE COILS. Comprising medium-wave frame aerial and long-wave loading coil, used as aerial coils. Midget iron-cored screened L.M. osc. coils, complete with circuit I.F. frequency 465 Kc., 9/6.

6 IRON-CORED COILS on Aladdin formers 13.5-50 metres, 198-550 metres, 950-2,000 metres. Tuned with a .0005 gang, I.F. frequency 465 Kc. Complete with circuit, 8/6.

METAL RECTIFIERS. 250 v. 60 mA., latest midget Selenium type, 6/6. 250 v. 100 mA. Midget Selenium, 7/6. P. & P. 6d. each.

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 2 ohms speech coil, 4/9 ; Push-pull 6 v. 6 matching 10-watt 2-ohms speech coil 6/9 ; 42-1 speech coil 2-ohm with extra feed-back winding, 4/3 ; Miniature 42-1 2-ohm speech coil, 3/3.

Twin-Gang Midget .00037 with perspex, dust-cover and trimmers, 8/6. Post and pkg. 6d.

Mains Droppers. 0.3 amp., 460 ohms, tapped 280 and 410, 1/6 ; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, 1/6 ; 0.3 amps., 950 ohms, tapped 700 and 825, 2/6 ; 0.2 amp., 1,000 ohms, vitreous, tapped, 2/6. Vitreous .3 amp. 700 tapped 680, 640, 600, 3/6. P. & P. on each 3d.

Volume Controls by famous manufacturer. Long spindle and switch, ¼, ½, 1 and 2 meg., 4/- each ; 20, 25 and 50 K., 3/6 each. Ganged control 3K and 5K, 3/6. Post and packing 3d. each.

Trimmers. 5-40 pf., 5d. ; 10-110, 10-250, 10-450 pf., 10d.

Three-bank, 50 pf., 1/3. Four-bank, 50 pf., 1/8.

Television Chassis : Size 9½ x 9½ x 3½in., 18 gauge steel cadmium plated complete with 5 coil cans size 1½ x 1in. with iron-cored former. These are wound for television frequency 6/6. P. & P. 1/6.

Wave-Change Switches. 6-pole 3-way, 2/- ; 4-pole 3-way, 1/9 ; 5-pole 3-way, 1/9 ; 3-pole 3-way, 1/9 ; 9-pole 3-way, 3/6. P. & P. 3d. each.

Line Cord. 3-way 0.3 amp, 180 ohms per yard, 1/3 per yard.

Ceramic P.F.S. 3 each of the following: 330, 220, 180 and 82, 2/6.

Twin-Gang .0005 Tuning Condenser, 5/-. With trimmers, 7/6. Post and packing 6d.

Television Coils wound in alican, size 2½ x ¾in. with former and iron core, 1/- each.

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32 mfd., 350 working	2/6
16 x 24, 350 working	5/-
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40 mfd., 450 working	3/9
16 x 8 mfd., 500 working	5/-
16 x 16 mfd., 500 working	5/9
8 x 8 mfd., 450 working	3/6
1 mfd., 500 v. working	1/6
32 x 32 mfd., 350 working	6/-
32 x 32 mfd., 350 working and 25 mfd., 25 working	6/6
50 mfd., 12 v. working	1/6
25 mfd., 25 working	1/6
250 mfd., 12 v. working	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd. 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
10 x 6 x 2 x 2 mfd., 500 v. wkg.	5/-
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Ex-Govt. 8 mfd., 500 v. wkg., size 3½ x 1½, 2 for	2/6

LINE AND FRAME SCAN COIL (removed from chassis) low impedance line, high impedance frame, 10/-. P. & P. 1/-.

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Frame Oscillator Blocking Transformer, 4/6.

Frame O.P. Transformer. Inductance 10 henry, ratio 10 : 1, 9/6.

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465 Kc. Midget I.F.s. Q.120, size 1½in. long, 1in. wide, ¾in. deep, by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6.

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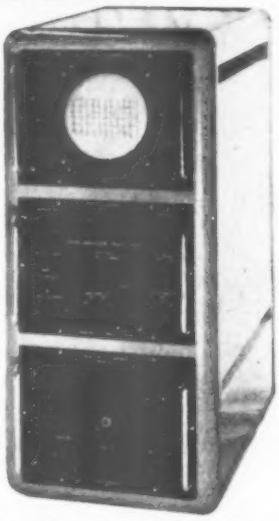

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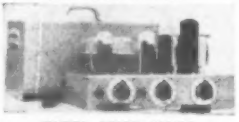

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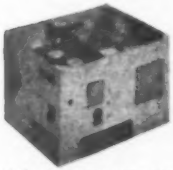

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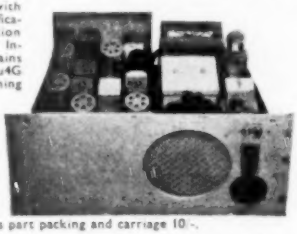

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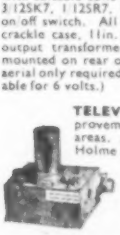

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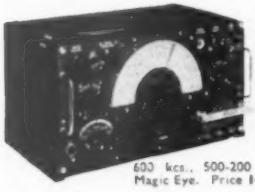

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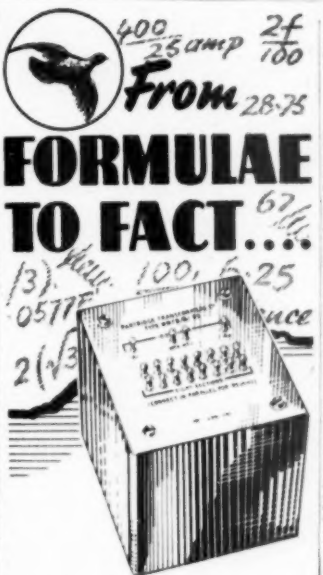

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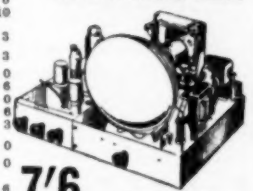

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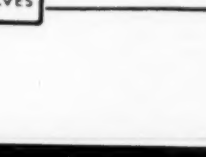

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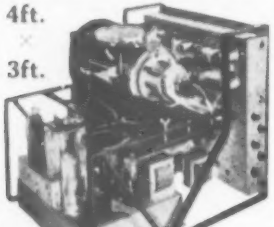

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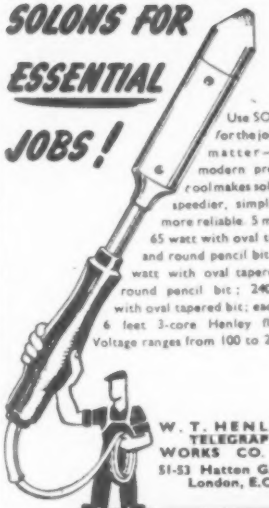

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388. CELL TESTERS, Admiralty patt. 1640, 4½in. scale, 0-3 amp. m/c meter, var. rheostat with scale graduated up to 12 by 1/10ths, then 14-16-18-20-40-60-80. A high grade job, perfect condition, in wood cases, **45/-,** post 1/8. A few with damaged wood cases, **30/-,** post 1/8. **368. AUTO TRANSFORMERS,** single phase, 50 c/s., 100 watts, tappings 0-10/120-200-230-250 v., other voltages available are 110-190-220-240 v. All terminations marked, a superior job, brand new, **21/-,** post 1/3. **24. AMMETERS,** hot wire, 0-9 amps., 2½in. scale, flush panel mounting. Brand new, boxed, **10/-** each, post 6d. **414. METERS,** m/c., 30-0-30 mA., 2in. scale, brand new, boxed, **12/6** each, post 6d. **VARIABLE RHEOSTATS** (223) "Zenith," 0.4 ohms, 25 amps., wire wound, helical screw traverse, base mounting, **7/6** each, post 1/6. (421) 60 ohms approx., 1 amp., wire wound, laminated slider operated by thumb wheel on threaded rod. New, boxed, **10/-** each, post 11d. **363. TANNOY MOVING COIL UNITS,** 5 ohms, D.C. resistance, suitable as an efficient moving coil microphone, powerful magnet, perfect condition, **8/6,** post 1/3. Tannoy input transformers to suit, **3/6** each, post 8d. **CONDENSERS** (442), 8 mfd., 475 v. max. wkg., 525 v. surge. Wire ends, tubular cardboard covered, English, **2/6,** post 3d. (443) Midget Electrolytic, 8 + 16 mfd., 450 v. D.C. wkg., **4/9,** post 3d. (446a) Bias condensers, 50 mfd., 50 v. wkg., **2/-,** post 3d. (446b) 25 mfd., 550 v. wkg., **2/-,** post 3d. **444. RESISTORS,** 5 watt, 250 v. + 5 per cent. Cement coated, wire wound, wire ends, current manufacture, **2/-** each, post 3d.; **10/6** per doz., post 6d. **445. RESISTORS,** wire wound: (a) 25 ohms, 3 watts, wire ends, **9d.** each, post 3d.; **8/-** per doz., post 6d.; (b) 25 ohms, 5 watts, wire ends, **9d.** each, post 3d., **8/-** per doz., post 6d. **372. MORGANITE POTS.,** all taken from new equipment, all fitted ¼in. shafts: (a) 5,000 ohms, (b) 10,000 ohms, (c) 20,000 ohms, (d) 50,000 ohms, (e) 0.1 meg., (f) 0.2 meg., all **2/6** each, post 3d. **410. VOL. CONTROLS,** Morganite. Fitted 250 v. 1 amp. switch, ¼in. shafts, 2¼in. long, brand new, latest type: (a) ½ meg., (b) ¾ meg., (c) 1 meg., (d) 2 meg., all **5/6** each, post 4d. **328. CHASSIS** for stripping. Size 12¼in. x 8in. x 2¼in., contain 12 v-holders, var. condensers, pots., coils, chokes and over 80 various condensers and resistors. Unused and clean, a real bargain at **10/-,** post 1/8. **390. INSULATION TAPE,** ¼in. wide, ½ lb. rolls in sealed tins, **2/6,** post 6d. **441. CROCODILE CLIPS,** nickel plated, **2/-** per doz., post 3d.; **21/-** per gross, post 6d. **13. TRANSFORMERS,** Pri. 200-220-240 v., Sec. 350-0-350 v. at 80 mA., 6.3 v. tapped at 4 v. at 5 amps., 5 v. tapped at 4 v. at 2 amps., screen. New, boxed, **20/-,** post 1/3. **161. TRANSFORMERS,** U.S.A. patt., 50-60 c/s., (a) Pri. 0-80-115 v., Sec. 6.3 v. 8 amps., **15/-,** post 1/3; (b) Pri. 0-80-115 v., Sec. 6 v. at 2.25 amps., **10/-,** post 11d. Note.—Two of these transformers can be used on 230 v. mains (primaries in series), secondaries can be used singly, in series or parallel as required. **365. CO-AXIAL CABLE,** radio freq., solid di-electric, outside dia. 3.8in., 10-foot lengths, brand new, **3/6,** post 8d. **426. CO-AXIAL CABLE,** 80 ohm 7/0076, p.v.c., 7.32in. dia., brand new, latest manufacture for T.V. aerials, 1/3 per yard. 100-yd. coils **£5,** post 1/8. **RADIO FREQUENCY AMMETERS,** 0.5 amp, thermo-couple H.F., panel mounting, square face, fit hole 2¼in. diameter. Brand new, boxed, **10/6,** post 6d. **RELAYS TYPE 3000,** 2-pole make, 2,000 ohms, platinum contacts, new, boxed, **12/6,** post 6d.

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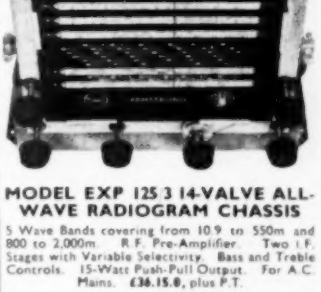

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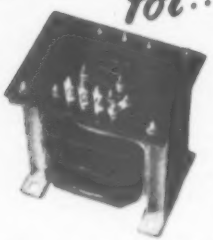

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FURTHER details, together with the necessary application forms, can be obtained from:—THE High Commissioner for New Zealand, 415, Strand, London, W.C.2, mentioning this paper and quoting reference No. S.47/28. Completed applications should be lodged not later than June 30, 1952. 18315

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RADIO Officer required by the East Africa High Commission for the Directorate of Civil Aviation for one tour of 48 months in the first instance. Commencing salary according to age and experience in scale £667 rising to £1,058 a year (including cost of living allowance). Gratuity between £74 and £96 a year payable on the satisfactory completion of final service. Outfit allowance £50. Free passages. Candidates under 40, should hold a First Class Certificate of Proficiency in Radio Telegraphy issued by the Ministry of Civil Aviation; or alternatively hold the Provisional Aircraft W/T Operator's Licence and have had not less than 1,000 hours flying experience on civil aircraft. Apply at once by letter, stating age, full names in block letters and full particulars of qualifications and experience and mentioning this paper to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting on letter M.25107/B. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration.

T.C.C. invite applications for positions as follows:—
(1) TECHNICAL Sales Representatives for radio and electrical industries, in Southern (London) and Northern areas.
(2) SALES Office Supervisors and Assistants with knowledge of industry and ability to handle semi-technical correspondence.
WRITE (in confidence) stating age, experience, salary required and which position applied for to Sales Director, Telegraph Condenser Co. Ltd., North Acton, W.3. 18525

SOUTH SHIELDS MARINE & TECHNICAL COLLEGE.
PRINCIPAL: J. Hargreaves, M.A., Ph.D. (Cantab.).
DEPARTMENT of Radio.
REQUIRED an Assistant Lecturer in Radio. Applicants should have some recognised professional qualification in radio. A sound knowledge of telegraphy and ability to teach this subject to candidates for P.M.G. Certificates would be an advantage. The salary will be in accordance with the Burnham Technical Scale for Assistants (Grade A), viz., £375-£10-£450 plus allowances where applicable. Full allowance will be made for industrial and/or teaching experience in assessing the initial salary.
FURTHER particulars and an application form may be obtained by sending a stamped addressed envelope to the Director of Education, Education Department, Town Hall, South Shields. Completed applications should be sent to the Principal within two weeks of the appearance of this advertisement.
A. J. W. JEFFERY, Director of Education.

THE following vacancies exist in a West Midland radio laboratory.
1. ASSISTANT Development Engineer, experienced in the design and construction of radio receivers, production of laboratory test instruments; qualifications, third year City and Guilds Telecommunications Engineering, intermediate Brit. I.R.E. graduateship or equivalent.
2. LABORATORY Assistant, age under 27 years, must have had practical experience in the construction of radio receivers, amplifiers or test instruments; qualifications, at least second year standard approved course in radio or electrical engineering.—Box 8789. (8485

The Foremost Name in Microphones

LUSTRAPHONE — THE MASTER MICROPHONE

FOR EXCELLENT RECORDING

LUSTRAPHONE have designed two models for use with Tape Recorders of all makes. Handsomely fashioned, both Table Stand Model C51 and Hand Model CH51 can be obtained in low or high impedance. Prices have been fixed at a very reasonable level and thus a fine instrument is available to all users. Leaflets sent on request.

MODEL C51

Handsomely finished in Grey Wrinkle, can be mounted on Table Stand. Moulded or heavy cast Base. On/off switch in case.

Prices:

Model C51 Low Impedance	£5 5s. 0d.
Model C51 High Impedance	£5 15s. 6d.
Type 52 Table Stand	£2 12s. 6d.
Type 52 B Heavy Table Base	£1 1s. 0d.
Type 52 MB Moulded Table Base	10s. 6d.

MODEL CH51

Handsomely finished in Black Wrinkle with Chrome Ribs. Special Rotary Dual action switch in case. 6 feet high quality cable.

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Model CH51 Low Impedance	£5 15s. 6d.
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ST. GEORGE'S WORKS, REGENT'S PARK RD., LONDON, N.W.1. *Telephone: PRImrose 6030.*

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ROGERS. New Baby de Luxe Amplifier with remote Tone control Unit	£18 0 0
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COLLARO 3 Speed Auto changers from	£11 16 9
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Daily demonstrations of above, hours 9.30 a.m.–6 p.m. 9.30 a.m.–1 p.m. Thursdays at

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EXPORT—IMPORT Enquiries invited.

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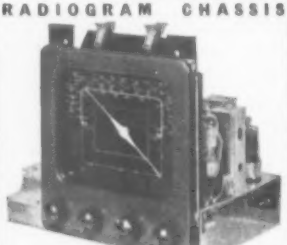
THE *HAYES RG/120* RADIOGRAM CHASSIS



The RG/120 chassis has recently been re-designed. The chassis is now four-band, new type coils and IF transformers are employed, together with an improved output stage. Inclusive price £15.0.0. A special AC/DC version is available 7-valve (6 one with push-pull output at £19.10.0.

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Demonstrations on Saturdays from 10 a.m. to 8 p.m. other days by appointment.

THE *HAYES* COMPANY

1 Alcester Road, Birmingham, 13

BRITISH ELECTRICITY AUTHORITY.

NORTH-WESTERN DIVISION

GENERAL Assistant Engineer required in Investigation Section of Technical Department at British Electricity House; salary £481/£674 (N.J.B. "A" Dixon). Candidates should possess H.N.C. in electrical engineering (preferably including courses in electronics) or equivalent qualification, and have experience in electronic engineering. Knowledge of power engineering would be an advantage.—Apply to Establishments Officer, British Electricity House, 525, Wilmslow Rd. Manchester, 20, not later than 7 days after the appearance of this advertisement, quoting Vacancy No. 702. [8471

COTTAGE LABORATORIES, Ltd., require the following staff:—

(a) PROJECT leader to control a division of electronic and electro-mechanical engineers; the applicant should be capable of leading a team of research and development engineers in a highly technical field; starting salary will be according to ability, experience and age.

(b) SENIOR electronic and electro-mechanical physicists or engineers; a physical and experimental outlook is desirable; the applicants must be capable of designing modern electronic circuits and of leading a group of assistant engineers; starting salary according to age and experience.

(c) ASSISTANT engineers interested in electronics and small mechanisms.

THERE are prospects of rapid promotion in an expanding laboratory; five-day week, excellent canteen and active sports club.

APPLY, stating age, nationality, previous experience and salary required to the Manager, Cottage Laboratories, Ltd., Portsmouth Rd, Cobham, Surrey. [8496

THE BRISTOL AEROPLANE Co., Ltd., invite application for the following vacancies:—

(a) ELECTRONICS Engineer, A.M. Brit. Radio Engineers, City and Guilds final, telecommunications or equivalent, with a wide experience covering transmitters, receivers, aerials, test equipment, etc.

(b) ELECTRONICS Instrument Maintenance Engineer, City and Guilds telecommunications or equivalent, with a wire experience of the maintenance of electronics instruments; an ex-R.A.F. long-service N.C.O. in the radio branch will also be considered.

(c) ELECTRONICS Instrument Draughtsmen, City and Guilds telecommunications Grade 2, Ordinary National Certificate Electronics Engineering or equivalent, with experience in the design of electronic instruments and apparatus.

APPLICATIONS giving full age, experience and qualifications should be addressed to the Ministry of Labour, 20 Nelson St., Bristol, 1, and marked for the attention of the Personnel Manager, The Bristol Aeroplane Co. Ltd., Aircraft Division, Filton House, Bristol. [8485

BUYER required for radio and electrical firm in South London area.—Write Box 8787.

AUTOMOBILE radio electrician required for Ford main dealer, S.W. London.—Apply Box 8797. [8507

MULLARD EQUIPMENT LIMITED, Wandsworth, have vacancies in their Engineering Dept. for the following:

(a) ELECTRICAL ENGINEERS.

(b) ELECTRO-MECHANICAL DESIGNERS.

(c) MECHANICAL DESIGNERS.

APPLICANTS should preferably have had experience in the design of electronic equipment (transmitters, receivers, instruments, etc.). Permanent pensionable posts. Salary according to experience and qualifications. Apply Personnel Department, MULLARD EQUIPMENT LTD., Bradbury Rd., S.W.16. [8517

SHOP foreman wanted for radio and electrical assembly; able to teach and supervise girl labour; South London district.—Write giving full details to Box 8794. [8473

ACCOUNTANT required for radio and electrical works employing 50-100 personnel in South London area.—Write stating experience, qualifications, etc., Box 8785. [8474

THE DE HAVILLAND AIRCRAFT Co., Ltd., require a junior radio engineer with current M.C.A. Air Licence required for aircraft installation testing and flying duties.

WRITE stating experience and salary required to the Personnel Manager, The de Havilland Aircraft Co., Ltd., Airspeed Division, Christchurch.

A LARGE British firm in the light electrical engineering industry requires the following specialists for its electronic laboratory located in the North part of London:—

AN experienced physicist having extensive knowledge of semi-conducting materials and of the modern theory of material structure. Applicants should have a practical approach to problems and be able to investigate and check on the practicability of developments and ideas.

TWO electronic engineers thoroughly familiar with pulse circuit experimental technique.

THE posts are permanent with contributory pension schemes and usual staff standards. Salaries will be considered individually and applicants should write to Box No. 528, Dorland Advertising, Ltd., 20, Regent St., S.W.1, giving full details of qualifications, experience, age and approximately salary range required.

WORKS manager required for radio and electrical factory to employ 50-100 personnel in South London area.—Write stating qualifications, experience, etc., to Box 8786. [8475

TELEVISION engineer, experience and competence on leading makes essential, permanent position, high salary, no overtime; able to drive. East London area.—Box 7286. [8202

RADAR mechanics.—Scanners, Ltd., Bill Quay, Gateshead 10, have a number of interesting jobs for men preferably experienced in R.A.F. ground radar, centrimetric and servo systems. [8465

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"Ten sets to solder!" cried EB.
"Before we pack up for to-day.
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With the help of FLUXITE.
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Wide range of all types available.
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WAVEFORM GENERATORS. We have been able to secure a further limited supply of these units which were so popular a few years ago for the wealth of useful parts fitted. Included amongst these are over 50 resistors, 35 condensers, relays, valve holders, tag boards, etc., and 15 valves (3—VR56's, 1—VR55, 2—VR54's, 2—VR65's or its improved version the VR116). **PRICE 47/6,** carriage 5/6.

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PLUGS and SOCKETS. We should like to draw the attention of commercial users to the very wide range of R.A.F. and American types of plugs and sockets we stock. We specialise particularly in those covered by the 10H., and 5X. references in the British series and Amphenol in the American range. Enquiries invited for both bulk and small quantities.

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Telephone: **Shepherds Bush 1729**

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VARIABLE CONDENSERS. 2 gang .0005, 7/- each ; .0035, 6 3 each ; 3 gang .0005, 7/- each ; 2 gang .0035 midget with dust cover, 8 6 each.

INSULATED SLEEVING. 1 and 2 mm. Bright colours, 1d. yard.

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SPECIAL PURPOSE VALVES. VR123 7/- ; 954 2 9 ; 955 5/- ; 956 3 3 ; VR137 5 9 ; VR136 6/- ; VU111 4 6 ; CV54 4/- ; E1148 2/- ; CV6 2/- ; CV9 4/- ; VU120A 4/- ; VT127 8 6 ; VT125 8 6 ; NT86B 6 6 ; VT91 7 6 ; VT86A 6 6 ; VT107A 9 6.

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MAIL ORDER ONLY. Please include postage : 6d. under 10/-, 1/- under 20/-, 1 6 under 40/-.

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(3) A SPECIALIST engineer with good academic qualifications having a sound knowledge of components and raw materials used in the radio industry; this vacancy is only suitable for an applicant who is experienced in electrical measurements and life testing of components.

THESE posts are permanent and pensionable and offer good opportunities for advancement.—Applications giving full details of experience and qualifications should be forwarded to the Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [8050

RADIO and television engineer, first-class man only need apply; comfortable conditions and good salary.—Apply Electrical Service (Edgware) Ltd., 117, Edgware Rd., W.2. Tel. Pad. 2342 by appointment. [8561

KEEN young electronics engineer (19-25) required to assist on T.V aerial and associated component design and development.—Write giving age, experience and salary required (N.W. area) Box 8808. [8554

ENGINEER of degree standard, B.Sc., engineering desirable, required for design and development of power capacitors. Should have knowledge of die-electrics and measurements. Apply Box 8805. [8512

ELECTRICAL test room assistants required urgently by well-known scientific instrument company situated in North London; technical education to O.N.C. standard an advantage.—Box 8099. [8524

F. K. COLE, Ltd. (Malmesbury Division), invite applications from electronic engineers for permanent posts in development laboratories, engaged on long-term projects involving the following techniques:—

1. Pulse Generations & Transmission.
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THERE are vacancies in the senior engineer, engineer and junior grades. Candidates should have had at least three years' industrial experience in the above types of work, together with educational qualifications equivalent to A.M.I.E.E. examination standard. Commencing salary and status will be commensurate with qualifications and experience. Excellent opportunities for advancement are offered with entry into Pension Scheme after a period of service. Forms of application may be obtained from Personnel Manager, Ekco Works, Malmesbury.

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SENIOR Experimental Officer (Ref. D17/52A) for the development in calibration procedure for radio test equipment and preparation of calibration publications. Duties will also include the calibration of substandards (against N.P.L. approved standards); specialist advice to Radio Equipment Calibration Centres and training of personnel for supervisory duties in these centres; liaison with the Radio Measurements Division in the Experimental Establishments of the Ministry of Supply.

EXPERIMENTAL Officer (Ref. D18/52A) and Assistant Experimental Officers (2) (Ref. D19/52A) for the calibration of transfer standards (a) involving frequency and pulse measurements, and maintenance of the frequency standard (b) involving bridge and miscellaneous measurements, and (c) involving output and attenuation measurements.

EXPERIMENTAL Officer (Ref. D6/52A) for the reconstruction of a radar landing aid and organisation of associated experimental investigation and to advise R.A.F. and contractors on associated problems. A knowledge of pulse systems and associated techniques is desirable and experience in current electronic practice and laboratory techniques essential.

CANDIDATES should have a Higher National Certificate or equivalent qualification in applied physics, radio or electrical engineering. Experience in the duties outlined above is desirable.

SALARY will be assessed according to age, qualifications and experience within the following inclusive ranges: S.E.O. (minimum age 35), £805—£1,055; E.O. (minimum age 26) £597—£754; A.E.O. (minimum age 19), £264—£555. Rates for women somewhat lower. Posts are unestablished.

APPLICATION forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King St., S.W.1, quoting appropriate reference. Closing date June 10, 1952. [8461

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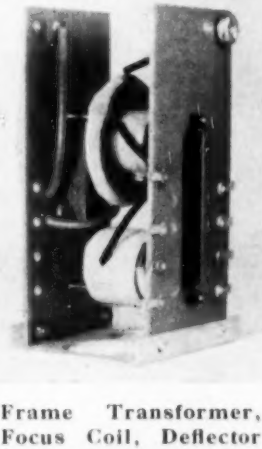
A New Line Transformer capable of fully scanning any Tube from 9in. up to 16in. (Double D) Scan at 16 Kv.



Frame Transformer, Focus Coil, Deflector Coil, Linearity and Width controls are available for wide angle tubes.

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13—50; 200—550; and 900—2000 meters

PRICE 30/- *(plus 12/10 P.T.)*

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Motor Flasher Unit. Contains small 24 v. motor coupled to a worm reduction gear running at about 60 r.p.m. and fitted with four sets of make and break contacts, connected to six mag. sockets. This unit is ideal for flashing signs, etc. 10/6. Post 1/6.

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Uniselectors, small. Siemens Minor switch, 3 banks of 10 contacts, ideal for radio control, etc. New and boxed. 25/-. Post 1/6.

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18 v. Relays Rotary Action, heavy duty silver contacts. Three sets of change over and one set of make contacts. 8/6. Post 1/-.

Selector Switches. 12/24 v. D.C., operates 4-way Yaxley switch, stops at each switch position, will make or step, ideal for 4-way remote control. Fraction of original cost. 3/6. Post 9d.

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Scanners Type 88. 10AR 9052. Containing Antenna, reflector 12in. dia. covered with perspex dome 18in. dia., 24v. drive motor, position transmitter motor, relay and suppressor gear. Brand new in crate £3.10/-. Carriage 10/-. DITTO with no perspex dome, store soiled. 30/-. Carriage 10/-.

Teleprinter Power Units. 230 v. A.C. Input 100 v. 1 amp output. Outer case is slightly rusty and dirty, otherwise these units are in perfect working order. Price 50/-. Carr. 7/6.

Selsyn Motors. Type 60. 18K/440 heavy duty, 1½in. x ⅝in. spindle. With heavy watertight brass case. 50/-. Post 2/6.

Coils for Wireless Set (No. 22). Complete set of 7 coils 7/6. Post 1/-.

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Phone: Brighton 25806

MAGNETIC TAPE RECORDERS and COMPONENTS
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SEND 1½d. STAMP FOR LIST SENT BY RETURN

G.E.C. GERMANIUM CRYSTAL DIODES
Midget Size, 5/16in. x 3/16in.
Wire Ends for Easy Fixing.
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Most gauges available.
B.A. SCREWS, NUTS, WASHERS
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TUFNOL ROD, PAXOLIN TYPE COIL FORMERS AND TUBES, ALL DIAMETERS.
ERIE AND DUBILIER RESISTORS.
Latest Radio Publications.
SEND STAMP FOR LIST. TRADE SUPPLIED
POST RADIO SUPPLIES
33 Bourne Gardens, London, E.4

EXPERIENCED engineer required by company in north-west England for design and development of television aerials and associated components.—Write, giving age, experience and salary required, to Box 8782. [8466

FERRANTI LIMITED, Manchester, have staff vacancies in connection with long-term development work on an important radio telecontrol project at their new laboratories at Wythenshawe, South Manchester.
(1) SENIOR Engineers or Scientists to take charge of research and development sections. Qualifications include a good degree in Physics or Electrical Engineering and extensive past experience in charge of development work. Salary according to qualifications and experience in the range of £1,000–£1,600 per annum. Please quote reference WS.
(II) ENGINEERS and Scientists for research and development work in the following fields: Radar, radio and electronic circuits, micro waves, high power centimetric valves, vacuum and/or high voltage techniques, servo control and electro-mechanical devices. Qualifications include a good degree in Physics or Electrical Engineering or Mechanical Science, or equivalent qualifications. Previous experience is an advantage but is not essential. Salary according to qualifications and experience in the range £500–£1,000 per annum. Please quote ref. WE.
(III) TECHNICAL Assistants for experimental work in the fields listed in (II) above. Qualifications required: a degree or Higher National Certificate in Electrical or Mechanical Engineering or equivalent qualifications. Salary in the range of £400–£600, according to age and experience. Please quote reference WT.
(IV) DESIGNERS and Draughtsmen. Section leaders, leading draughtsmen, draughtsmen and junior draughtsmen, preferably with experience in any of the fields mentioned above. Salaries based on A.F.S.D. rates, in the range £350–£650 per annum with good allowances for special qualifications and experience. Please quote reference WD.
THE Company has a Staff Pension Scheme. Application forms from Mr. R. J. Heibert, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote appropriate reference. [8535

DRAUGHTSMAN required for power equipment. At least ordinary national certificate and general engineering workshop experience. Salary according to age and experience.—Write full details to Box 6804. [8511

RADIO mechanic wanted, experience of aircraft V.H.F. equipment preferred but not essential; good basic knowledge of H.F. or M.H.F. will be considered.—Apply Air Work, Ltd., R.N.A.S., St. Davids, Pembs. [8584

EXPERIENCED high-class electronic fitter & wiremen required for industrial and research development work at The English Electric Co., Stafford; ex H.M. Forces personnel with experience in radio and radar considered.
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ELECTRONIC service engineer required for work in laboratories; experience of fault-finding and measuring instruments essential; good prospects and salary.—Apply in writing to E.R.D., St. Margaret's Studios, Twickenham.

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DRAUGHTSMEN age 21-25 required, preferably with experience of small electrical mechanisms; good working conditions.—Write stating age, experience and salary required to Chief Draughtsman, The Record Electrical Co. Ltd., Broadheath, Cheshire. [8469

SERVICE manager required for rapidly expanding communications organization in London; applicants should have a technical background in V.H.F. technique and sound administrative experience.—Particulars of past experience and salary required to Box 8780. [8460

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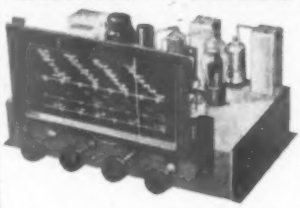

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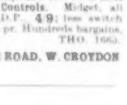

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MURPHY RADIO, Ltd., have vacancies for a designer draughtsmen in their electronic division; a varied programme ensures opportunity of widening experience with excellent prospects.—Apply giving particulars of training and experience to Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [8469

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QUALIFIED accountant required by Merseyside electrical engineers (175 employees) must have commercial experience, energy and initiative essential, but sound prospects accordingly; salary £550, according to ability and experience; please reply in own handwriting giving full details of training and exp.—Box 7299.

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GLOSTER AIRCRAFT Co., Ltd., of Hucclecote, Glos., have vacancies for electrical draughtsmen; private aircraft experience an advantage but not essential; prospects are excellent for energetic and sound applicants.—Applications to be addressed to the Chief Designer, giving particulars of experience, age and salary required. [8470

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A LEADING company in the radio and electronic industry setting up a new laboratory in the West London area has vacancies for electronic engineers, draughtsmen, and model makers of all grades. Applicants for these vacancies should give full details of qualifications and experience and should state salary required.—Apply Box 8098. [8523

REQUIRED, laboratory engineers (junior) National Certificate standard, for hearing aid and electronic instrument factory, High Wycombe; 5-day week; canteen, pension scheme accommodation found if required.—Give full details of experience, age and salary required in confidence, to Box M.3383, Haddons, Salisbury Square, London, E.C.4. [8586

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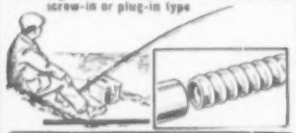

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ELECTRONIC wiremen required to assist in manufacture of prototype high-grade television and government equipment; must be capable of reading circuit diagrams of all types and of wiring to a high standard; staff appointment; 5-day week; pension scheme.—Write, telephone or call Cinema Television, Ltd., Worsley Bridge Rd., Lower Sydenham, S.E.26. Arrangements made with local employment exchange. [8477

ONE or two experienced radar or electronic engineers, also engineers experienced in servo mechanisms, are wanted for a guided weapons project by English Electric Laboratory, Luton; progressive post with a starting salary of £600 to £1,000 per annum, according to experience.—Write giving full details, quoting Ref. 456B, to Central Personnel Services, English Electric Company, Limited, 24-30, Gillingham St., London, S.W.1. [8551

POST Graduate and Final Year University Students in physics, electrical and mechanical engineering and metallurgy are invited to send details of their records to the Staff Manager (Ref. GBLC/S 674), Research Laboratories of The General Electric Co., Ltd., Wembley, Middlesex. A number of openings in interesting experimental research will be available during the coming months for men with outstanding abilities and qualifications. [8529

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A COVENTRY engineering company have vacancies for laboratory technicians, preferably having a knowledge of physics and chemistry as applied to electrical industry; the work is associated mainly with the application and properties of insulating materials, and a knowledge of the rubber or plastics industry would be an advantage, though this is not necessary; permanent employment with prospects.—Write stating age, exp., salary.—Box 8797.

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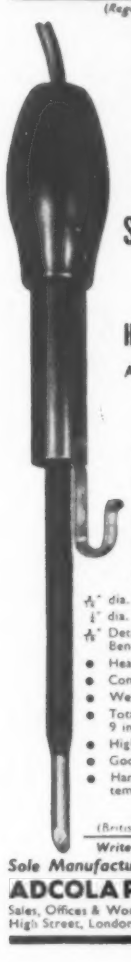

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ENGINEERS and physicists with experience in the following fields are required by the G.E.C. at the Stanmore Laboratories: (a) servo-mechanisms, (b) microwave aerials, transmitters or receivers, (c) small mechanisms, (d) electronic circuitry, (e) D.C. amplifiers, (f) test gear for field trials. Preference will be given to men with good academic qualifications. Applications should be sent to the Staff Manager (Ref. GBLC/S/875), G.E.C. Research Laboratories, Wembley, Middlesex. [6521

ASSISTANT foreman required for workshop engaged in the assembly of miscellaneous electronic equipment; essential requirements: Several years' experience of electrical instrument production preferably in the telecommunications, radio or Radar fields; good theoretical knowledge of electronics and preferably previous supervisory experience; good prospects and conditions, and superannuation scheme; London area.—Write, giving age, full details of experience and salary required to Box 6778. [6554

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E., or possess equivalent qualifications together with similar laboratory experience; salary will be commensurate with previous experience, 5-day week, contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [6445

APPLICATIONS are invited by an expanding electronic engineering company in Buckinghamshire for the following vacancies: Technical assistants with experience of electronic equipment; senior engineer with B.Sc. engineering in electronic subjects, preferably telecommunication, and at least three years' experience of electronic equipment; accommodation may be available later.—Please write, giving full details and salary required, to the Personnel Officer, Airmec Labs., Ltd., High Wycombe. [6447

ENGINEER required to take charge of a section engaged on research in connection with airborne receivers by Marconi's Wireless Telegraph Co., Ltd., Chelmsford. An attractive salary will be offered to a suitable applicant who must have had good experience in this field. The position is one of responsibility and is permanent. Pension scheme, etc.—Please write in confidence giving full details and quoting reference 875A to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham St., London, S.W.1. [6505

RADAR engineers, senior and junior, required with B.Sc.(Eng.) or Chartered Electrical Engineer Diploma, or equivalent. Applicants should have had at least three years' experience in works and laboratory with experience on pulse work preferably centimetric. Transmitters: duties will involve acting as liaison between development and research departments and the works; they will also be required to prepare works test specifications and advise on test equipment.—Write, stating fullest particulars and salary required, to Box 8110. [8556

VACANCIES exist in a development laboratory engaged in frequency control systems, work which requires initiative and ability to work from basic ideas. Applicants must have at least H.N.C. and some industrial electronics experience. In the near future the laboratory will move to a country location where housing will be available to all suitable applicants.—Apply in writing giving full details of academic and other qualifications to the Personnel Manager, Standard Telephones and Cables, Ltd., North Woolwich, London, E.16. [8564

SENIOR circuit engineers are required by the English Electric Co., Ltd.; experience of designing time bases, stabilised power packs and cathode ray monitoring circuits is essential; a degree and an interest in production development is desirable; good salaries will be paid to those appointed to these responsible positions.—Applicants should write stating preference for London or Midlands area, giving full details and quoting reference 921A to Central Personnel Services, English Electric Co., Ltd., 24-30, Gillingham St., London, S.W.1. [8457

SEMI-conductors.—The Research Laboratories of The General Electric Co., Ltd., Wembley, Middlesex, have vacancies in the expanding field of semi-conductors and semi-conductor devices for physicists and engineers and also for physicists with a chemical bias or physical metallurgists; preference will be given to honours graduates with some previous experience; these openings offer good opportunities for advancement.—Applications should be sent to the Staff Manager (Ref. GBLC/O/897) stating age, experience and qualifications. [8526

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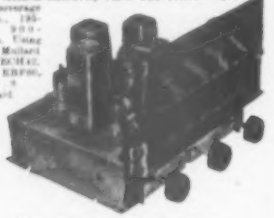

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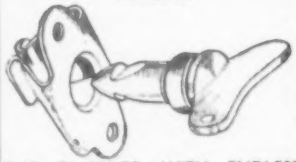

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A DRAUGHTSMAN is required in a laboratory in the Surrey area, engaged on development of aircraft electrical equipment; he will be required to produce detailed drawings of components and component layouts for electronic and similar equipment, and to assist in their mechanical design; minimum qualifications should be equivalent to the Ordinary National Certificate in Mechanical or Electrical Engineering, and some experience in light engineering work is essential.—Apply, giving experience, qualifications and salary required to Box 8803.

A FEW vacancies exist in the research laboratories of Marconi's Wireless Telegraph Co., Ltd., Chelmsford, for engineers for work on the circuit application of transistors. Although academic qualifications are valued and applicants should at least possess H.N.C., the type of work demands an experimental approach and a practical outlook is therefore essential.—Applications stating age, qualifications and experience, quoting Reference 972.5, should be addressed to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham St., London, S.W.1.

RADIO and television mechanic.—A large light electrical engineering company, in the West London area, require a radio and television mechanic for their engineering laboratory; applicants should have a good working knowledge of domestic electrical and mechanical appliances, including radio, television and industrial electronics; minimum qualification Higher National Certificate (Electrical); special knowledge of electronics an advantage; good conditions and pay.—Write, giving details of age, qualifications and experience, to Box 8798.

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ELECTRONIC engineers with several years' research or development experience are invited to apply for posts with a well established company engaged on the development of precision laboratory instruments; applicants should preferably possess an Honours Degree or equivalent qualifications in physics or light electrical engineering, although this is not essential as considerable practical experience is equally acceptable; the appointments are of a permanent nature for engineers of ability who are capable of developing new projects to the prototype stage, and offer scope for the exercise of individual initiative; the work is of absorbing interest and covers a wide range of electronic instruments; salaries are commensurate with qualifications and experience.—Applications should be made in writing to the Personnel Manager, Furzehill Labs., Ltd., Boreham Wood.

MINISTRY of Supply require physicists and electrical engineers with knowledge and experience of one of the following for posts in the experimental officer class at a research establishment near Sevenoaks: (1) Electronic circuit design with particular reference to V.H.F. region or pulse technique; (2) experimental and development trials of equipment, including field trials; (3) development of electromechanical devices; (4) measurement of transient phenomena in connection with electrical and explosive equipments; (5) radio for telemetry work; (6) design of aircraft radar, some experimental flying will be required; (7) development work on electrical components, preferably with experience of component design or inspection; candidates should have a minimum of Higher School Certificate, with a science subject as a principal subject, but those over 20 will generally be expected to have a Pass Degree or a technical qualification of similar standard, e.g., Higher National Certificate in Physics or Electrical Engineering; salary will be assessed according to age, qualifications and experience within the inclusive ranges: Senior experimental officer (minimum age 35) £808–£1,053, experimental officer (minimum age 26) £597–£754 p.a., assistant experimental officer (minimum age 18) £264–£555 p.a.; rates for women somewhat lower; the posts are unestablished.—Application forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1, quoting D170/52A. Closing date 14th June, 1952. (8545

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APPLICATIONS are invited by the Ministry of Supply for posts in the experimental officer class at R.A.E. signals experimental establishments to assist in one of the following: 1 (a) General experimental work in connection with design of high power long distance radio telegraph systems or radio communications and radar systems D 171/52A; 1 (b) aerial and feeder systems D 172/52A; 2, site selection and installation design of large radio receiving and transmitting stations, radio telegraph terminal offices, or radio airfield approach and landing aids D 173/52A; 3, experimental and development work associated with small electro-mechanical machines for machine telegraph systems D 174/52A; 4, development and test of prototype mobile and portable radio and radar installations D 175/52A; 5, engineering trials and investigations of modern automatic telegraph and line equipment D 176/52A; post 1(a) is located at Ruislip; posts 1(b), 2, 4 and 5 at Medmenham, and post 3 at Kidbrooke; candidates should have a minimum Higher School Certificate with a science subject as principal subject, but those over 20 will generally be expected to have a Higher National Certificate or equivalent qualifications in applied physics, radio or electrical engineering; experience in the duties outlined above is desirable and knowledge of R.A.F. signals equipment would be an advantage; salary will be assessed according to age, qualifications, experience and location within the following inclusive ranges: Experimental officer (minimum age 26) (posts 1(a), 2, 3 and 4) £597-£786, assistant experimental officer (posts 1(a), 1(b), 2 4 and 5) £264 (age 18)—£571; rates for women somewhat lower; posts are unestablished.—Application forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King St., S.W.1, quoting Reference No. Closing date 14th June, 1952. [8544

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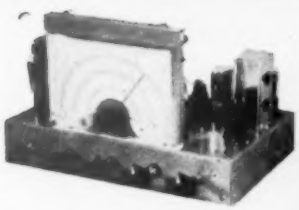

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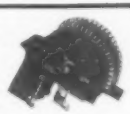

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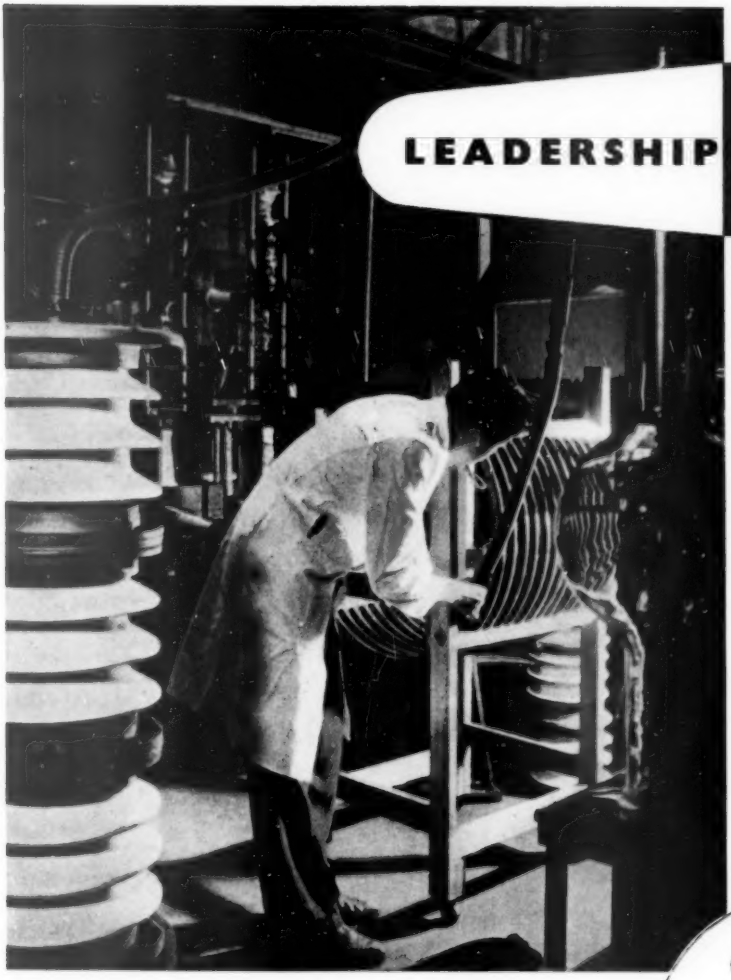

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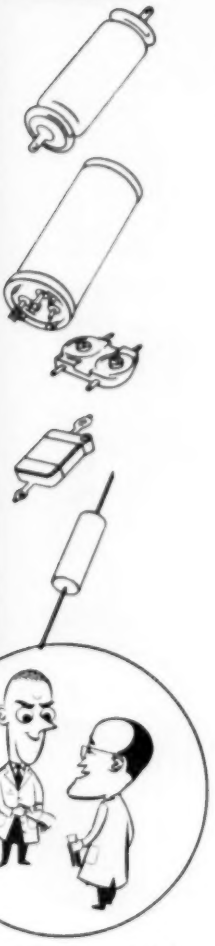

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The illustration shows final checking in high-voltage test bay.

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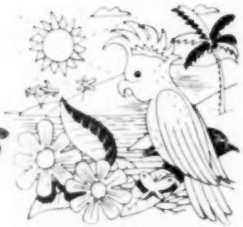
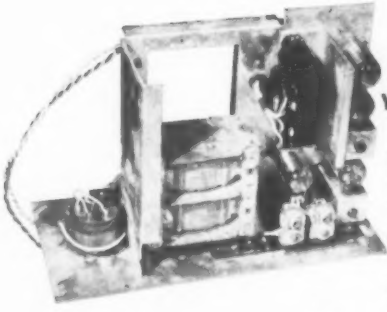


or to the dry arctic cold

joints soldered with

ERSIN MULTICORE

will not corrode



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C 14013	40/60	13	13 feet
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